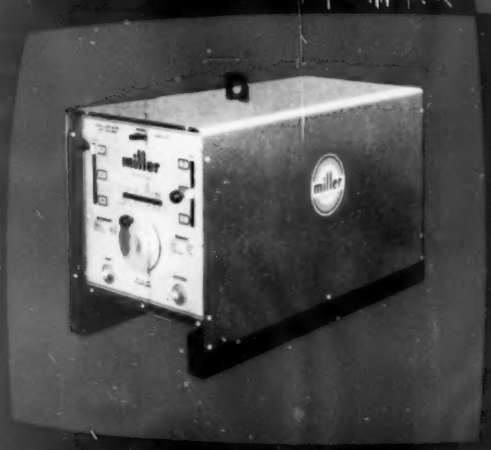
Welding Engineer

PRICE 50 CENTS

SEPTEMBER, 1959

180 AC/DC



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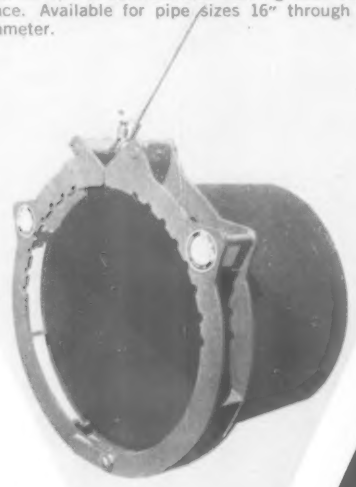

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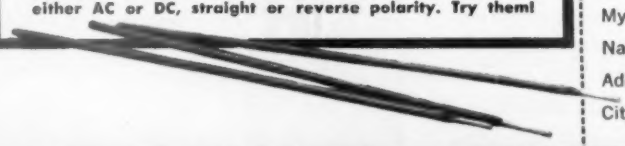

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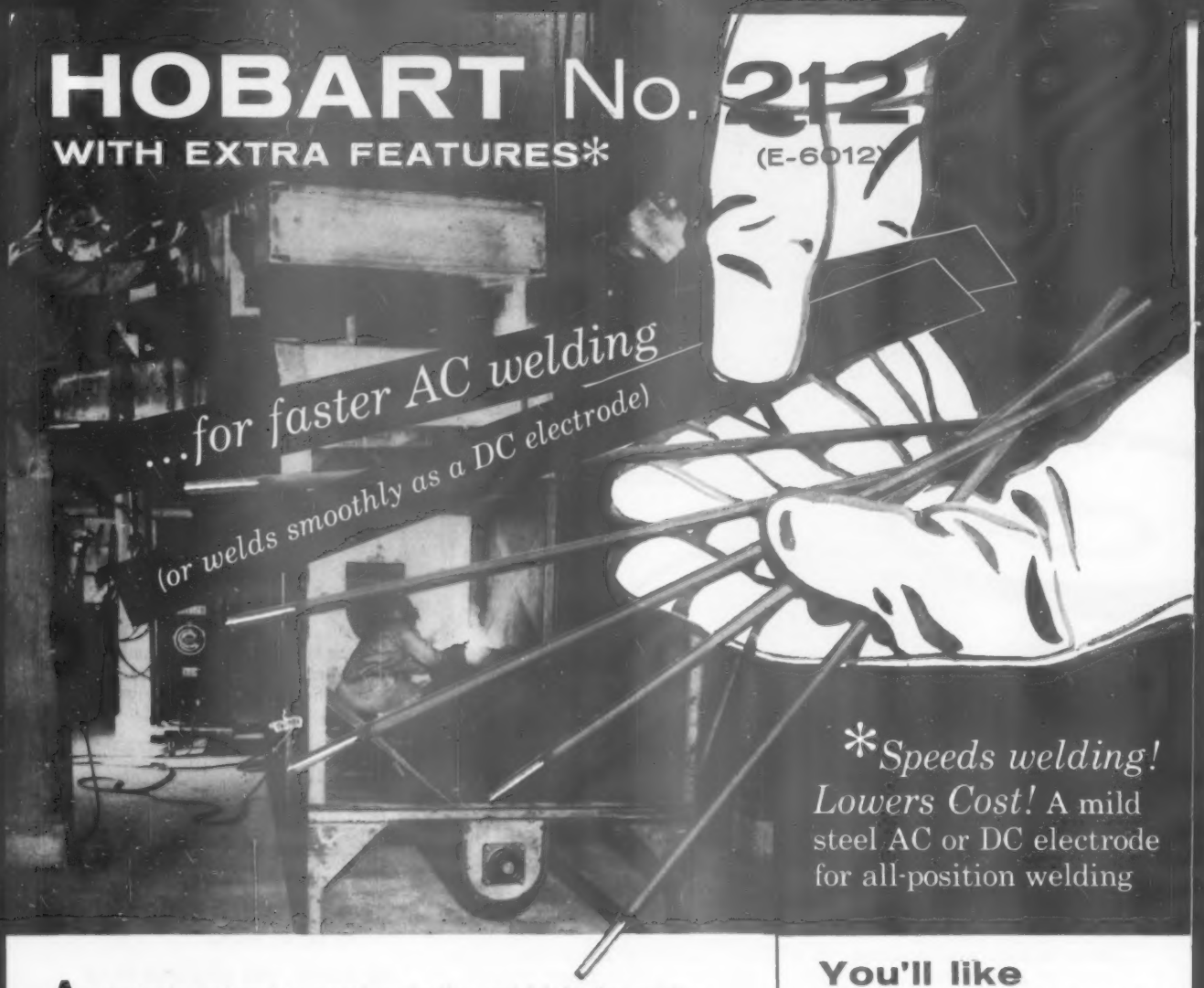

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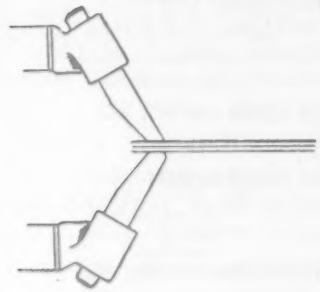
VOL. 44—No. 9

Welding Engineer

The magazine of joining and severing materials

This is welding: September, 1959



How to get better stainless steel welds 32

Certain basic fundamentals are applicable to welding any stainless steel; and knowledge and constant practice of these principles will spell the difference between success or failure on a job. Author **W. L. Wilcox** explains these procedures for better stainless welds.

★ (For a reprint of this article, circle number 249.)

Spot welding procedures and design 35

The success of a spot welding application depends on the various factors involved in this economical joining method. **Lester F. Spencer** details these factors in this first article of a two part series explaining procedures and design.

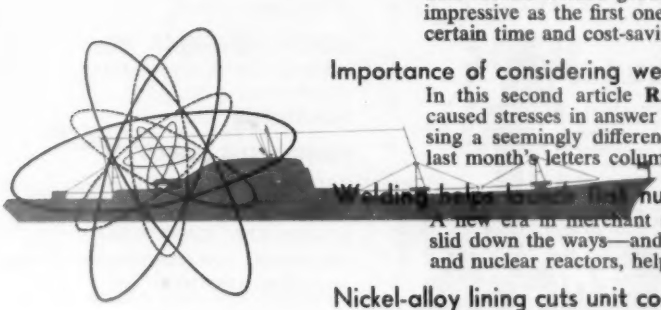
Understanding weld distortion and shrinkage 40

Since weld heat is at the root of most distortion and shrinkage, author **George W. Gardner** shows, through several examples, how proper understanding and use of heat-produced contraction can help fabricate strong, distortion-free weldments.

★ (For a reprint of this article, circle number 250.)

Geodesic dome replaces railcar repair plant 44

This second welded geodesic dome built for Union Tank Car Co. is just as impressive as the first one in Baton Rouge—and more economical because of certain time and cost-saving methods used.



Importance of considering welding stresses reviewed 48

In this second article **R. E. Holt** gives a further explanation of welding-caused stresses in answer to a letter, which appeared in the July issue, expressing a seemingly different viewpoint. The author's first rebuttal appeared in last month's letters column.

Welding helps launch first nuclear-powered merchant ship 50

A new era in merchant shipping was opened recently when *N. S. Savannah* slid down the ways—and welding, being an old hand at this business of ships and nuclear reactors, helped her along.

Nickel-alloy lining cuts unit costs 58

Today's demands for high-octane gasolines can only be met if economical, high corrosion-resistant refining units are first fabricated. **John F. De Lorenzo** reports on his company's practical solution to the problem.

Also in this issue:

Chicago utility conducts pipe welding course 46
Tig welding, aluminum used for transformer cases 43
Welding aids farmer in work, at home 31
Hand welding still most economical in many cases 52
Jet airliners sealed with stainless steel 56
Plush motel, plush pool, plush rink 62
Michigan school supplys area with weldors 82
Welded steel flat cars increase efficiency 84

Regular **WE** features . . .

News 7
Your WeldWorld at press time 15
30 years ago 16
Letters 18
Between passes 25
Editorial: *Obsolete before he starts* 29
Welding Clinic: *How to keep air pure* 54
Data Sheet: *Proposed RWAA electrode numbers* 81
New Products 94
People 103
Book reviews 107
Free literature 110
The Welding Shopper 111
Advertisers in this issue 112
Literature offered in ads 112
Welding Info-Aids 113

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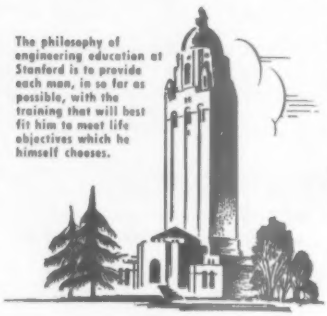

This vacuum bellows is part of the liquid target assembly located on the business end of the linear accelerator developed by Stanford University. The bellows is .0106" brass, joined to half-inch-thick Muntz metal flanges. This is a difficult brazing job at best—being done successfully at Stanford University, using Silvaloy 45. Heating is by torch and carbon block. Needless to say, despite the technical difficulties of this job, only a perfect, strong vacuum-tight joint is acceptable.

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WELDING ENGINEER is indexed regularly by Engineering Index, Inc.

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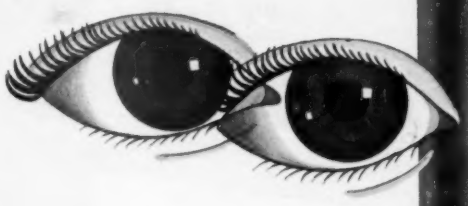

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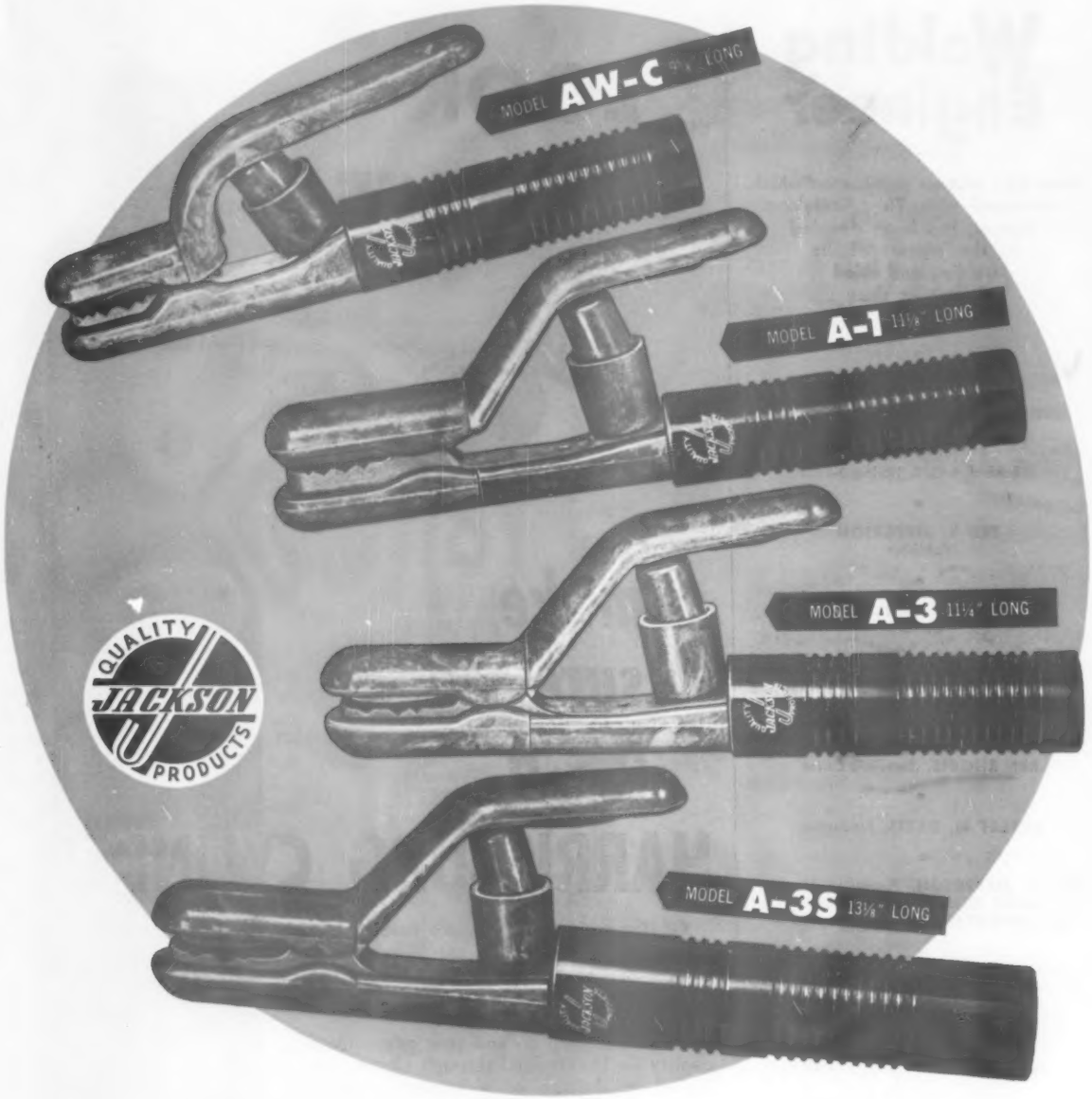

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Tongs of heat treated 98% copper alloy with high-impact, heat resistant glass fiber insulators permit highest duty cycles with a wide margin of safety.

For top production, select the holder best suited to the job at hand. The table at the right rates these holders by duty cycle, that is the percentage of arc time in any ten-minute period of work, depending on rod size, amperage and cable size.

Holder Class	Model	Electrode	Amps & Cable	Duty Cycle
Small	AW-C	7/32"	250-1 300-1/0	50%
Medium	A-1	1/4"	300-1/0 350-2/0	50%
Large	A-3	3/8"	375-2/0 450-3/0	65%
Heavy-Duty	A-3S	3/8"	500-4/0	80%

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Welded spider for Niagara power project

THIS 27-ft-diameter generator half is being welded at Westinghouse Electric Corp.'s East Pittsburgh, Pa., works. When fabrication and machining are completed, the 25-ton piece will be joined with a matching half for installation in one of thirteen 167,000-kva water-wheel generators for the $720,000,000 New York State Power Authority's Niagara Power Project.

M&T makes available complete welder line

Availability of a complete line of arc welding machines has been announced by the Welding Division, Metal & Thermit Corp., New York City.

The new machines will be produced to M&T specifications by three different suppliers. Mid-States Welder Mfg. Co., Chicago, will manufacture manual a-c transformer machines, d-c rectifiers, a-c/d-c machines, inert arc welding machines, and auxiliary equipment in ratings from 130 to 500 amp.

Rotary generator welding machines will be made by Harnischfeger Corp., Milwaukee, and controlled arc power supply automatic and semi-automatic d-c machines will continue to be manufactured by Glenn Pacific Power Supply Corp.

Speakers, topics set for titanium conference

Speakers and topics have been settled upon for New York University's College of Engineering fifth annual conference on titanium to be held September 14 and 15 on University Heights campus in the Bronx.

Among the papers to be given are "Welding of titanium and titanium alloys," by Carl Hartbower, Watertown Arsenal; "The behavior of spot fusion welded RS 120 B and RS 140," by Harry Mattes, Republic Steel Co.; and "Radiant quartz lamp brazing of titanium honeycomb structure," by Harry Schwartzbart, Armour Research Foundation.

GE welding controls moves to Detroit

The resistance welding control business of General Electric Co., Schenectady, N. Y., has been moved to the company's service shops at 5950 Third Ave., Detroit.

At the new location, parts will be engineered, manufactured and marketed, as well as renewed and repaired.

Most of the apparatus needed has been moved from the former Waynesboro, Va., facility, but complete relocation will not be concluded until the end of the year.

Meanwhile, the company has put in operation a new controlled atmosphere facility at its Schenectady power tube plant which is said to improve the reliability and life of metal electron tubes used in welding control panels. Reliability is said to be increased because the new unit prevents undetected contamination from being sealed into tubes.

The new process calls for controlled atmosphere assembly rooms, hydrogen baking of parts and rigorous inspection and maintenance of stored parts awaiting assembly. The final assembly area is humidity-controlled, with air filtered and room pressurized to eliminate contaminants. It is vacuumed daily and an air-lock entry system is used.

Industrial Air opens new Idaho plant

Industrial Air Products Co., Portland, Ore., has opened a liquid oxygen and distributing facility in Boise, Idaho. Galen Ebright is managing the operation.

This is the company's sixth branch installation, with the main plant being in Portland.

The firm is also constructing a $70,000 plant in Richmond, Calif., to house welding wire production facilities.

Next month . . .

Titanium

Zirconium

Tantalum

. . . and how to weld them.

The October issue of WELDING ENGINEER will be a special edition devoted to these and other highly reactive metals.

New welder supports Redstone missile plan

A new welder developed jointly by Miller Electric Co., Appleton, Wis., and the Army Research Development Laboratories, Ft. Belvoir, Va., is being used to weld thin gage materials needed for fabrication of Redstone missiles.

The trailer-mounted welder is gasoline engine driven and provides a-c or d-c current for both metal arc and Tig welding.

The machine has 1 kw, 115 volt d-c auxiliary power while welding; 10 kw, 115/230 volt a-c single phase, 60 cycle power; built-in high frequency stabilizer for continuous use or for starting, and 20-gallon coolant system.

Ultrasonic seam welder to aid packagers

A recent advance in high speed ultrasonic seam welding of light gage aluminum sheet and foil will greatly aid container and packaging manufacturers, says its developers.

The new process is the result of a cooperative program between Aeroprojects Inc., West Chester, Pa., and Aluminum Co. of America, Pittsburgh.

The firms say it is now possible to use ultrasonics to seam weld sheet and foil in thicknesses ranging from 0.006 in. to 0.010 in. at speeds in excess of 30 ft per minute.

When using thinner materials, speeds above 100 ft per minute have been reached, and conservative estimates by program engineers are that this rate will be doubled in the near future.

One advantage of ultrasonic welding is that seam welds can be stopped and started abruptly, without first producing long start up seam sections of inferior quality.

The process developed by the West Chester firm is characterized by relatively non-critical strip cleaning. Degreasing is all that is required for most aluminum alloys. In addition, the method uses low power equipment, with a line power demand of less that four kilowatts in the seam welding done to date.

Packaging firms, automobile radiator manufacturers and the electrical industry are now considering ultrasonic welding of aluminum as a way to achieve increased production and greater economies.

Ryan Industries obtains National Cooler Corp.

Ryan Industries Inc., Cleveland, has taken over the activities of National Cooler Corp. The firm will headquarter at 888 E. 70th St. in Cleveland.

National Cooler manufactured a line of liquid-oxygen cylinders. The firm introduced one of its cylinders at the Industrial Oxygen Manufacturer's Association at the latter's 1957 Chicago meeting.

POWDER-cutting flame process is speeding remodeling at Huntington Memorial Hospital in Pasadena, Calif. Process employs a mixture of iron and aluminum powder which is fed into an intensely hot oxyacetylene flame. Process is being used to cut doorways 9 ft by 5 ft in 16-in. reinforced concrete at rate of 6-ft per hour. Powder-cutting is ideal for work at hospitals, officials say, since noise, vibrations and dusts are eliminated. The Linde Co. process is being used on job by Concrete Flame Cutters Inc., Burbank, Calif.

COMING EVENTS

SEPT. 17, 24; OCT. 1, 8, 15: Chicago Section AWS Educational Lectures, "Practical Metallurgy II," Chicago Bridge and Iron Dome, Chicago.

SEPT. 24-25: NWSA Central Zone Meeting, Statler Hilton Hotel, Detroit.

SEPT. 28-29: NWSA Eastern Zone Meeting, Hotel Roosevelt, New York City.

SEPT. 28-OCT. 1: National Fall Meeting of the AWS, Sheraton-Cadillac Hotel, Detroit.

OCT. 19-20: NWSA West Central Zone Meeting, Pick-Nicolett Hotel, Minneapolis.

OCT. 19-23: 47th National Safety Congress and Exposition, Chicago.

OCT. 22-23: NWSA Western Zone Meeting, Riviera Hotel, Las Vegas.

NOV. 2-6: 41st National Metal Exposition and Congress, International Amphitheatre, Chicago.

NOV. 19-20: University of Wisconsin Annual Welding Institute, "Stainless Steel Welding," Wisconsin Alumni Center, Madison.

NOV. 30-DEC. 1: NWSA Southeastern Zone Meeting, Atlanta Biltmore Hotel, Atlanta.

DEC. 3-4: NWSA Southwestern Zone Meeting, Hotel Texas, Fort Worth.

JAN. 20, 1960: Metallurgical Society of AIME, Flat Rolled Products Conference, Del Prado Hotel, Chicago.

APRIL 25-29, 1960: 41st Annual Convention, AWS, The Biltmore Hotel, Los Angeles.

APRIL 26-28, 1960: AWS Exposition, Great Western Exhibit Center, Los Angeles.

MAY 5-7, 1960: NWSA 16th Annual National Convention, Palmer House, Chicago.

MAY 9-13, 1960: Southwestern Metal Exposition, State Fair Park, Automobile Building, Dallas, Tex.

SEPT. 6-16, 1960: Production Engineering Show, Navy Pier, Chicago.

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Olin Mathieson Chemical Corp., New York City: Steel Distributors Inc., Philadelphia; M. L. Foss Inc., Denver; McCormick Steel Co., Houston.

Amperex Electronic Corp., Hicksville, L. I., N. Y.: Variety Electronics Corp., Bloomfield, N. J.

All-State Welding Alloys Co., Inc., White Plains, N. Y.: Seaboard Oxygen Service, Plymouth, N. C.; Welders Supply Co., Beloit, Wis.; Kirk's Auto Electric Inc., Bowling Green, Ky.; Viotti y Cia, Buenos Aires, Argentina.

Tube Turns, Louisville, Ky.: Speakman Co., Inc., Wilmington, Del.; Empire Machinery & Supply Corp., Norfolk, Va.; John Hack Co., Woodbury, N. J.; Eastern Pennsylvania Supply Co., Inc., Wilkes Barre, Pa.

Nasco Inc., Birmingham, Ala.; Welder and Industrial Services Inc., St. Louis, Mo.; Cummings, McGowan and West Inc., St. Louis Mo.; Greenwood and Co., Gainesville, Tex.

(Additional news on page 93)

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only $89.50

By all means — look at other "package" outfits first to make you the more certain that this one is the best for you.

• • •

here's why this combination welding and flame cutting outfit is actually the very finest your money can buy...

This new outfit, the Five Star Pak, was designed particularly for the smaller shop, for farm use, garages, the hobbyist, or any one whose welding and cutting operations are diversified and more limited in scope and metal thicknesses . . .

An economy outfit can be economical only if it will perform well and for many satisfying years to come. If it fails to meet highest standards, it ceases to merit all consideration . . .

Extendable? By all means. This Five Star Pak is amazingly versatile. It may be extended as the needs expand. Larger or smaller nozzles or tips fit the torches as do multiple flame nozzles so convenient for many brazing operations. The cutting attachment, for instance, may cut easily up to four inches of steel thickness.

You can buy with confidence from a company which has been in the business of making fine equipment for nearly fifty years.

WRITE FOR THE ILLUSTRATED FOLDER #17 which gives you all of the information you ought to consider . . .

552 DEPT.

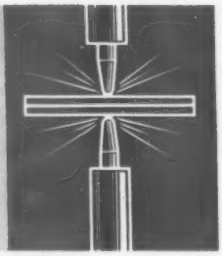
NATIONAL welding equipment company... 218 fremont street san francisco 5 california

P R MALLORY & CO Inc

MALLORY MEMOS

NEWS AND TIPS ON RESISTANCE WELDING

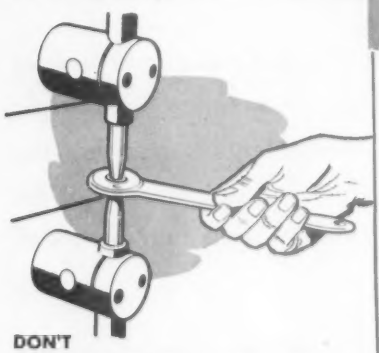
P. R. Mallory & Co. Inc., Indianapolis 6, Indiana



WELDING HINTS

DO

Keep the tip taper and holder taper clean, smooth and free from foreign deposits. You'll get a "first-class" weld every time with a minimum of arcing. For best results, use precision-machined Mallory tips and holders.



DON'T

Never permit spot welding tip to mushroom enough to make dressing difficult—better to dress it regularly to be sure of getting consistently good welds.

Send for this useful chart of 34 Do's and Don'ts for Resistance Welding. Hang it on the wall in your shop for handy reference.

To Weld Quick-Melting Metals Use MALLORY Low-Inertia Holders

Yellow brass, red brass, aluminum and similar metals are tricky to spot or projection weld. They change so quickly from a solid to liquid state that the sudden loss of pressure often causes burning or flashing at the weld.

Mallory low-inertia holders solve this problem by giving you a quick, low-friction follow-up of pressure. You can select the pressure you need, just by interchanging springs . . . done in seconds. Our new line of low-inertia water-cooled holders give you these features:

- bearing support close to pressure application
- rapid pressure follow-up, low friction
- wider pressure range
- no current conduction between sliding members
- rugged construction
- interchangeable electrode adapters
- easily maintained in your own shop
- efficiently water cooled
- horizontally rotating cables for maximum clearance

Low-inertia holders are also useful for cross wire welding of non-ferrous materials where multiple spots are desired. They make your big welding machines more versatile by adapting them to low pressure or low-inertia welding. They're part of the extensive Mallory line of standardized holders, electrodes, welding wheels, and supplies.

Mallory welding products are available from authorized distributors located in all principal cities.

This is all the room you need to weld with LINDE's "MIGHTY MIDGET"

. . . New Heliarc HW-20 Torch

HIGH CURRENT CAPACITY

Operates at 200 amperes *continuous* duty, AC or DC. Molded, totally closed water-cooling system eliminates any chance of leaks at torch head.

MINIATURE SIZE

9/16- by 2-5/16-in. torch head permits welding in hard-to-reach areas as small as 3 in. in diameter. Total torch length is under 7 inches.

3.3-OZ. FEATHERWEIGHT

Selected materials, such as glass fiber reinforced phenolic plastic, save weight without sacrificing strength. Torch (with short cap) weighs only 3.3 ounces.

HANDLES LIKE A PENCIL

Exceptional balance, light weight, small size, and super-flexible service lines make the HW-20 torch as easy to handle as a pencil.

For further information, call your local LINDE Office or LINDE Distributor . . . or write: Dept. WE-09, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

The terms "Heliarc," "Linde," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

SPECIFICATIONS

Capacity —
200 amp. AC or DC, continuous duty cycle;
225 amp. AC or DC, reduced duty cycle

Weight —
with short cap: 3.3 oz.*
with medium cap: 3.5 oz.
with long cap: 3.6 oz.

Length overall — 6⅞ in.

Length of Torch Head —
with short cap: 2-19/64 in.*
with medium cap: 3-9/32 in.
with long cap: 7-5/16 in.

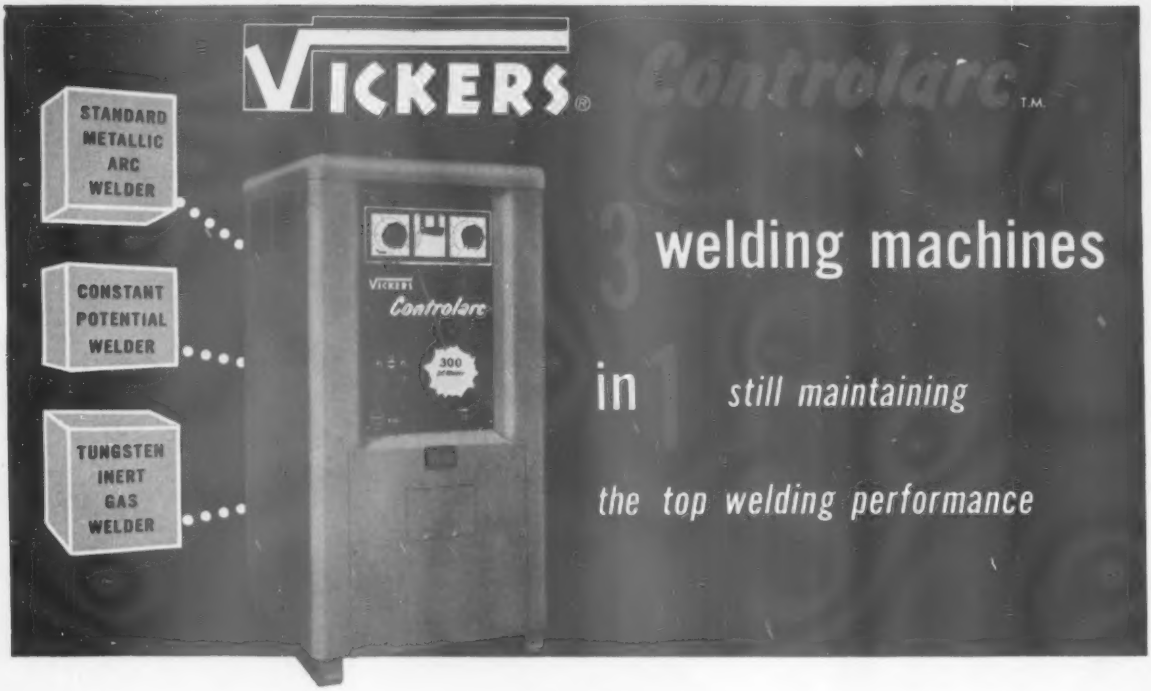
Maximum Handle Diameter — ¾ in.

Maximum Head Diameter — 9/16 in.

Service Lines — 12½ or 25 ft.

*Torch is supplied with medium cap for 3-in. electrodes. Short cap for 2-in. electrodes and long cap for 7-in. electrodes are available as accessories.

Linde UNION CARBIDE



In this versatile welder, Vickers has combined:

1. Standard Arc Welding
2. Constant Potential Welding
3. Tungsten Inert Gas Welding

in ONE Outstanding Machine.

The price is less than half of separate machines!

And this combination has been achieved *with no loss of complete welding performance.* Standard or CP operation is superior to operation of competitive individual machines. Now you can do almost any welding job from this single source, without an expensive investment in multiple machines.

NEW—From Vickers . . . 500 Amp. Constant Potential Welder

Can be paralleled to give any current for any semi-automatic or automatic job requiring direct current constant potential power.

- Built in remote control receptacle.
- Voltage adjustable (stepless) from approx. 13 to 36 volts.
- Slightly falling output slope—may be adjusted internally to flat or slightly rising for special conditions.
- Hot start adjustable. May be internally adjusted to any desirable degree.
- High speed of response.
- No moving parts.
- Quickly paralleled for high output requirements.

■ Contact our nearest welder dealer for prices or call factory!

■ Write for special descriptive bulletins 7136-1 and 7146-1.

EPA 7110-2

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ELECTRIC PRODUCTS DIVISION
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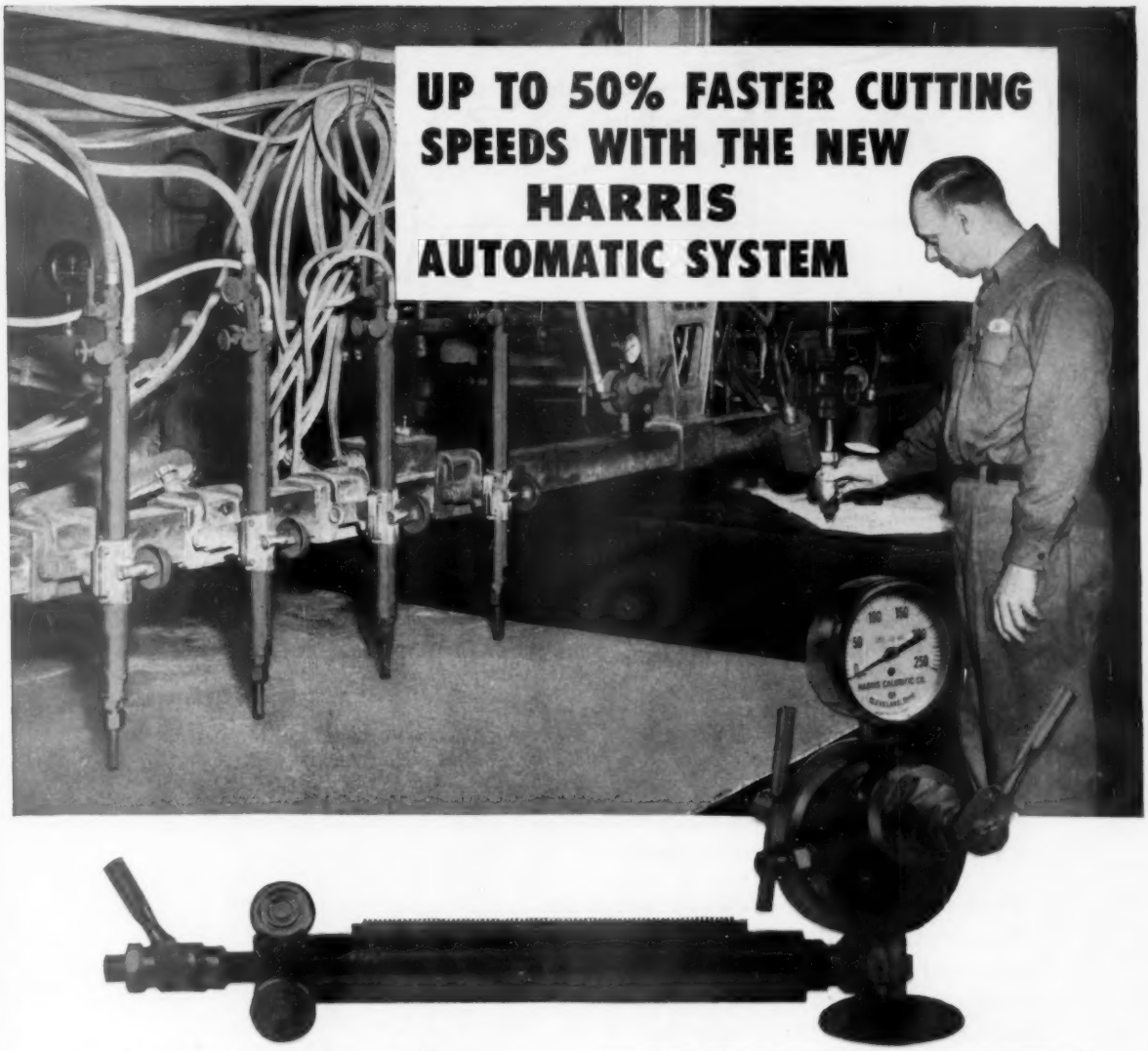


UP TO 50% FASTER CUTTING SPEEDS WITH THE NEW HARRIS AUTOMATIC SYSTEM

It takes just the flick of a wrist. You can now control pre-heat oxygen pressures to as many as eight machine cutting torches simultaneously! Working from your regular operating position, and using the new Harris system, you get unbelievably smooth, fast cutting results!

You get faster starting, piercing and cutting than ever before with the Harris unit. Independent control of the starting flame enables you to vary one without affecting the other.

✓	Up to 50% faster cutting speeds over older methods.
✓	80% reduction in consumption of pre-heat oxygen. Overall oxygen consumed lowered. 20%.
✓	Slag removal reduced to a minimum.

For more details, see your nearest Harris distributor or write to us.

HARRIS

HARRIS CALORIFIC CO.

5501 CASS AVE. • CLEVELAND 2, OHIO

During the past twelve months, WELDING ENGINEER editors have traveled 60,000 miles in search of facts, details and opinions. As you can see by the map, the 60,000 miles of reporting covered most of the important welding areas of the country.

These 60,000 miles of travel include trips to conventions and trade shows, important industrial projects, plants and welding institutes. WELDING ENGINEER editors have learned that first-hand reporting is the means to better analysis and presentation of the news.

What all this travel means to the reader and advertiser is simple—it means accurate and often exclusive information—it means *WE* has an ear to the heartbeat of the industry. It's little wonder that WELDING ENGINEER can see and set the trends in the welding industry today, and because this is true, *WE* is welding's most respected publication.

The 60,000 miles of travel this year were for you; just another one of the reasons why the editorial content of WELDING ENGINEER makes it the most sought-after welding publication today.

60,000 miles of reporting for you!

WELDING ENGINEER

Your September, 1959

Weld World

As WE went to press, these were the industry's latest developments:

. . Metal & Thermit Corp. has sold its M & T Welding Products Corp. (a subsidiary) to Glenn Industries Corp. New name of the manufacturer of heavy-duty power supplies for automatic welding is Glenn Pacific Power Supply Corp., Oakland, Calif. George G. Glenn is president.

. . Continuing increases in labor and materials are gradually pushing prices upward. Manufacturers of oxyacetylene welding and cutting equipment are latest to contemplate price boosts.

. . Our report of the sale of Cambridge Corp., Lowell, Mass., has been confirmed. Standard Steel Corp., Los Angeles and Decatur, Ill., has purchased the operation from Carrier Corp. Cambridge will operate as a division of Standard.

. . Independent gas distributors have a new source of liquid or gaseous argon as a result of an agreement between Southern Oxygen Co., Hyattsville, Md., and Spencer Chemical Co., Kansas City, Mo. Latter's new Messer liquefaction plant at Vicksburg, Miss., will supply the argon to Southern Oxygen, who will make it available to independents throughout the Southeast.

. . Climax Molybdenum Co. of Michigan, subsidiary of American Metal Climax, Inc., New York City, has reduced prices on its moly products. At same time, Climax announced availability of a moly-base alloy with 30% tungsten.

. . Man-made diamond abrasive products are being sold by The Carborundum Co., Niagara Falls, N. Y., at the same price as natural diamond products—wheel for wheel. Carborundum was first to fabricate General Electric's man-made diamonds into abrasive wheels.

. . Weldable ductile cast iron production will triple this year and climb to 100,000 tons annually, says The International Nickel Co., Inc.

. . Welded rail continues to blanket the nation's rights of way. Linde Co. reports that 16 railroads will weld a total of 500 miles of track during 1959 using its Ribbonrail process.

. . . What sounds like hardfaced aluminum has been announced by Alcoa Research Laboratories. Aluminum castings and forgings, with precision welded zones of super-hardness and high wear resistance are expected to find use in many automotive applications.

. . Conflicting reports about steel situation, so pay your money and take your choice. Some industries already hurt by lack of steel (A. O. Smith Corp. reportedly closed one pipe mill), while others claim they have enough steel on hand to ride out a three-month-plus strike.

. . As WE went to press, Kennecott Copper was struck by two unions—Mine-Mill and United Steelworkers. Possibility of strike spreading to other producers loomed large.

. . Avco Mfg. Corp., New York City, through its Research & Development Div., has entered the plasma torch field. Small generator is designed to flame spray ceramics and refractory metals at 15,000 F.

Brazing rods

to meet AWS-ASTM specifications

AMPCO-BRāZ®

Produced from start to finish by one reliable company

Packaged for easy handling and stocking

AMPCO-BRāZ No. 1
(AWS specifications, RB Cu Zn-D)

Low-fuming, high-strength, high nickel rod for joining and overlay with the oxy-acetylene process. Bonds readily to copper-, iron-, and nickel-base metals and alloys.

AMPCO-BRāZ No. 4
(AWS specifications, R Cu Zn-B)

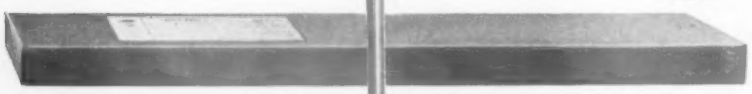
Low-fuming, manganese bronze rod with nickel added for higher strength and ductility. For brazing and braze-welding high-strength bronzes and brasses, steel, cast iron, and malleable iron with the oxy-acetylene process.

AMPCO-BRāZ No. 2
(AWS specifications, R Cu Zn-C)

Low-fuming, high-strength, manganese bronze rod for brazing and braze-welding steel, cast iron, malleable iron, and copper and its alloys with the oxy-acetylene process.

AMPCO-BRāZ FLUX No. 2

Saves time on general welding, cast-iron welding, and brazing. Has many other advantages.



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W-153

30 YEARS AGO

(Taken from the WELDING ENGINEER of September, 1929)

—30 YEARS AGO—

J. F. Lincoln of Lincoln Electric Co., Cleveland, has sailed for London where he will demonstrate a new carbon arc welding process.

—30 YEARS AGO—

F. T. Llewellyn, president, will preside over the American Welding Society when it takes part in the National Metal Congress to be held in Cleveland starting Sept. 10. AWS speakers will include H. L. Whittemore, I. T. Hook, J. R. Dawson, J. J. Crowe, H. M. Priest, A. B. Kinzel, J. C. Lincoln and H. C. Price.

—30 YEARS AGO—

The new 40-story Union Carbide & Carbon building in Chicago will have all-welded steam, fire and sprinkler lines.

—30 YEARS AGO—

The Cleveland School of Welding, Cleveland, is still going strong under Edward Scott's direction.

—30 YEARS AGO—

Art Bernard, Chicago, attended the recent branch managers meeting of Fusion Welding Corp.

—30 YEARS AGO—

"Economy factors in field welding," by W. R. Ost, Air Reduction Sales Co., says that pipeline welders earn 85 cents an hour, while helpers are paid 50 cents. Oxygen delivered costs $1.25 per 100 cu ft, and acetylene $2.60 per 100 cu ft.

—30 YEARS AGO—

The 1929 Model A Ford uses 1,339 resistance welds in its construction.

—30 YEARS AGO—

The Sutton-Garten Co. has just completed a modern fireproof building in Indianapolis.

—30 YEARS AGO—

Chester T. Price will assume the duties of secretary of the Gas Products Association at Chicago on September 1.

—30 YEARS AGO—

The United Welding Co., Middletown, Ohio, has begun a program to produce large diameter all welded steel pipe.

"Leave scratchin' an' peckin' to the chickens—

Use AIRCO EASY ARCSTARTS!"

The first time you try Airco's new EASY ARCSTART Electrodes you'll never go back to scratchin' an' peckin' with yesterday's electrodes.

Welding mild or low alloy steel, or hardfacing? Airco EASY ARCSTART Electrodes enable you to *use lower amperage for starting, if desired; strike an arc the first time; and do it easier than ever before.*

The tip coating does the trick. This is the cap at the striking end of EASY ARCSTART Electrodes – a special metallic compound that instantly initiates arc current.

Airco EASY ARCSTART Electrodes are available in diameters from 1/16" to 5/32"... for mild steel, low alloy steel and some hardfacing electrodes.

For samples, write on your letterhead... or phone your nearby Authorized Airco Dealer. He's listed in the Yellow Pages under "Welding Equipment and Supplies".

AIRCO®

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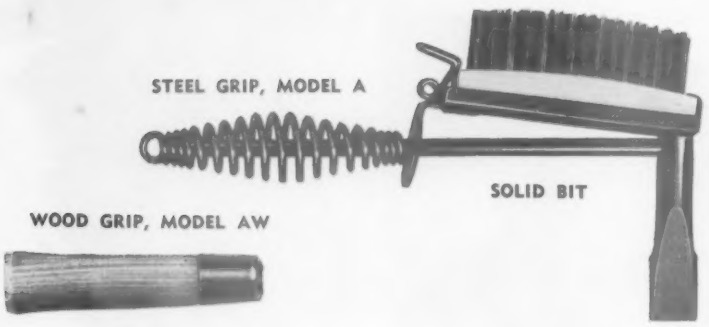
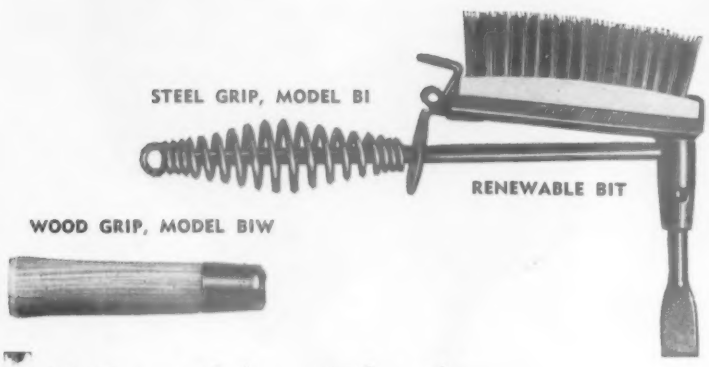
ATLAS | WIDE-BLADE TOMAHAWKS

WORLDS LEADING WELD CLEANING TOOLS





If Possible—They're Better than Ever!

Atlas "Dual Tools" are favorites with welders who like the idea of having the brush handy at all times. Now these tools are even more efficient than ever with our new wide blades—18% more chipping edge, more speed, fewer resharpenings, less worker fatigue. Choose your "Dual Tool" with the grip you prefer and the bit that best suits your likes. Ask your dealer for our FORM WCT-250 describing all our models.

Tough as they come!

33 MODELS

Each Atlas tool is made as well as we know how. Ask your welding supply dealer to show you the complete line.

ATLAS WELDING ACCESSORIES INCORPORATED
707 E. LEWISTON
FERNDALE 20, MICH.

Letters . . .

Letters should be addressed to: The Editor, WELDING ENGINEER, P. O. Box 28, Morton Grove, Ill. No letter will be published unless signed, but your name will be withheld if requested.

Crusade aid

Sir: *Chicago*

The outstanding cooperation of the magazine industry during the American Cancer Society's 1959 Crusade has been a revelation to me. The generous donation of space to alert the public to life-saving messages about cancer and to the need for funds to fight it is a contribution of immeasurable value, and we are most grateful.

Please accept both my personal thanks, and those of the volunteers and staff of the American Cancer Society, for your important help in the continuing fight against cancer.

David L. Harrington
National Crusade Chairman

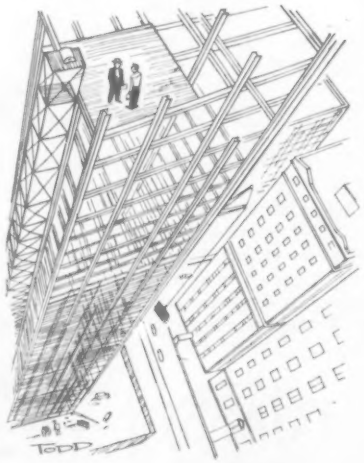
Creeping socialism

Sir: *Santa Ana, Calif.*

I wish to compliment you on your July editorial (p. 19) "183 years of progress."

The subject matter is all so true, I'd like to suggest that you do . . . similar comparisons . . . in future issues. . .

Having been very interested in good government—through Chamber of Commerce activities, National Association of Manufacturers, National Federation of Independent Business . . . I find it very difficult to understand how busi-



"We could use you. Are you willing to start at the bottom?"

MANHATTAN MOLDISCS

CUT FASTER... LAST LONGER

Manhattan Moldiscs are made in types to meet specific job requirements for use with mild steels, stainless alloys, aluminum or copper. Tests prove they're the most economical portable wheels you can use on right angle grinders . . . smoothing weldments, removing burrs, beveling edges. Manhattan Moldiscs cut cleanly and freely on the toughest roughing and finishing—without loading or glazing. They're safer to use, too, because they're light in weight, easy to handle . . . and reinforced with special super-strength synthetic fabric for greater safety. Manhattan Moldiscs do a better grinding job, and they last longer!

Ask a Manhattan abrasive wheel engineer to demonstrate the advantages of Manhattan Moldiscs . . . available in a wide range of types from harder, stiff bonds for roughing—to resilient, flexible bonds for fine finishing.

To get "More Use per Dollar" also on other grinding or cutting jobs . . . specify Manhattan custom made, high speed, heavy duty abrasive wheels.

- FREE CUTTING
- REINFORCED FOR GREATER SAFETY
- WILL NOT LOAD OR GLAZE
- LIGHTWEIGHT, EASY TO CONTROL
- SPECIAL BONDS FOR ROUGHING AND FINISHING

"More Use Per Dollar"

RM849

WRITE TO THE ABRASIVE WHEEL DEPARTMENT

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Belts • Hose • Roll Covering • Tank Linings • Industrial Rubber Specialties • Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

GB 88 FLUX..*available in 3 oz., ½ lb., 1 lb., 5 lb. jars and 25 lb. drums to suit your needs*

Use GB 88 Flux, the flux of proven dependability and note the improvement in the quality of your Silver Brazing. GB 88 is fully active to 1650°F.

Low glare and low fuming characteristics insure operator comfort and quality results. It is stable in use as well as in storage and was developed for Silver Brazing of STEEL, BRASS, COPPER, STAINLESS STEEL, MONEL, NICKEL, INCONEL, CHROME ALLOYS, SILVER and GOLD.

For best results team up GB 88 Flux with GB Silver Brazing Alloy in the form or size you require: random coils (all diameters), strip, straight lengths, pre-formed rings and special shapes. Prompt service on all inquiries.

90th ANNIVERSARY

Goldsmith Bros. SMELTING & REFINING CO.

111 N. Wabash Ave., Chicago 2, Ill. • 74 W. 46th St., New York 36, N. Y.

OAKLAND

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nessmen, or even the public, can remain complacent, apparently assuming that everything will be all right.

In practically every instance where government is discussed, we hear speakers talk about creeping socialism, and everybody seems to accept it as a fact. Most of us hope, however, that before this socialism gets up and walks right in, we can . . . stop it by bringing the facts to the public through every possible media.

You are helping in this objective through your publications, and I urge your continued effort.

V. B. Anderson
Executive vice president
National Welding Supply Association

Aluminum dip brazing

Sir: *New York City*

In your May issue of *The Welding Clinic* you describe and summarize the dip brazing process for aluminum. This short resume was well written for the space alloted but, unfortunately, lacked the latest wrinkle in the picture—Handy Alumibraze.

Solder clad sheet and wire preforms both have their limitations as means of replacing the brazing alloy. Handy Alumibraze overcomes these limitations and provides a more complete method of applying the filler metal.

Handy Alumibraze is a brazing alloy flux paste which, when furnace dried, cements the brazing filler metal in place at the joint. Even during immersion in the salt bath, the flux-cement retains the brazing alloy until it is molten, at which time, it is drawn by capillary action into the joint. The flux-cement then dissolves in the salt bath becoming a useful part of the bath.

F. J. Fahrendorf
Brazing Products Div.
Handy & Harman

ATOM·ARC* Pipe Welding Alloys

*IRON POWDER LOW HYDROGEN ELECTRODES

provide x-ray quality welds—lower welding costs at

NATIONAL VALVE AND MANUFACTURING CO.

less rework, no grinding or chipping, faster deposition rates, are time savers that boost profits.

Photos Courtesy NATIONAL VALVE & MANUFACTURING COMPANY

National Valve and Manufacturing Co., fabricator and erector of quality piping for American industry, has consistently been among the leaders in the piping industry for the last half century. This large, engineering-minded organization maintains its position of leadership through research to constantly improve methods and facilities—testing and selecting the latest in materials that will provide their clients with the finest quality high pressure, high temperature piping.

NAVCO research into welding techniques and materials resulted in the selection of ATOM·ARC All Position Iron Powder Low Hydrogen alloys for handwelding of pipe fabrications and for field erection. The X-ray quality of ATOM·ARC weld metal eliminates needless rework. The flat, smooth bead contour makes slag removal easy, requires no costly and time consuming chipping and grinding, allowing weldors more time for welding. Even finish grinding of the final pass is eliminated. These cost saving properties of ATOM·ARC electrodes are amplified by the fast deposition rate achieved from the iron powder type coatings.

These are the facts NAVCO found in their search for better materials for high quality piping . . . facts which prove ATOM·ARC Iron Powder Low Hydrogen Alloys produce superior piping products. For your free copy of an informative and revealing report to piping contractors, write to:

Alloy Rods Company, P. O. Box 1828, York 2, Penna.

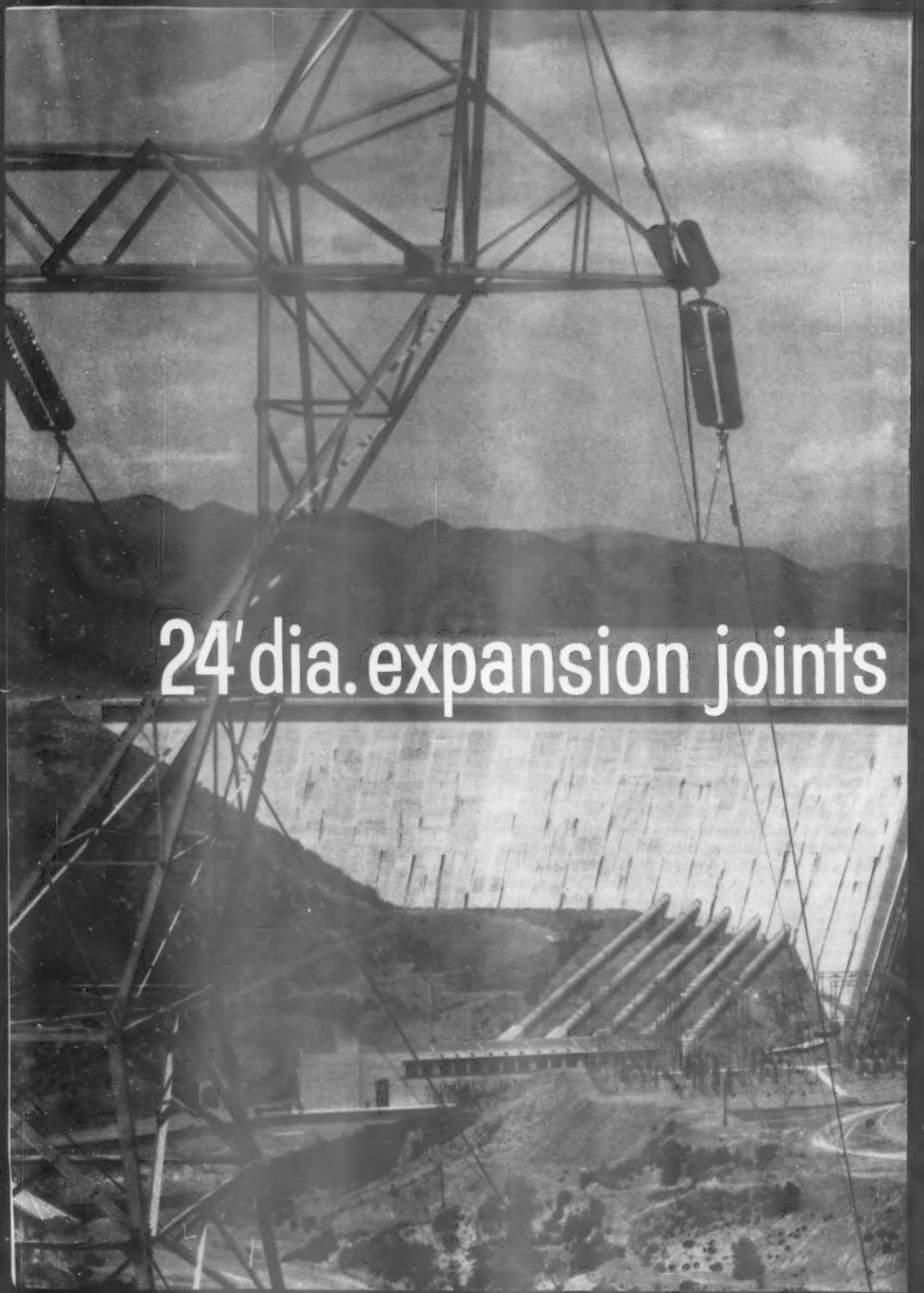
WORLD'S LARGEST SELECTION—IRON POWDER ALLOYS

ATOM·ARC 7018 Mo	AWS E7018-A1
ATOM·ARC 8018 N	AWS E8018-C2
ATOM·ARC 8018 CM	AWS E8018-B2
ATOM·ARC 9018 CM	AWS E9018-B3
ATOM·ARC 10018 MM	AWS E10018-D2
ATOM·ARC 12018 NMV	AWS E12018-G
ATOM·ARC "T"	AWS E11018-G
ATOM·ARC 502	AWS E502-16

Alloy Rods Company

YORK, PENNSYLVANIA • EL SEGUNDO, CALIFORNIA

NO FINER ELECTRODES MADE . . . ANYWHERE


24′dia. expansion joints

Stainless steel expansion joints
for penstocks 24 feet in diameter
are no easy job for the fabricator.

It is a problem of fixturing,
metallurgy and welding.

Alert Steel Products Company
took the job and
were successful on the first try.

Before beginning to tool up,
Mr. Jules Davis, Alert's President,
called in the man
who specializes in welding problems—
the Lincoln Welding Engineer.

The Lincoln man, Tom Farris,
suggested submerged arc welding
with a "Mechanized Squirt"
18/8 wire and a special flux
for welding stainless—ST-100.

Then, Mr. Farris and Mr. Ed Klein,
Alert's Chief Engineer,
planned the fixturing to give
rigid support while welding.

fabricated in stainless

by Submerged Arc Welding

Result: On the first try
the 10,000-pound ring
(one-half of one joint)
was welded in eight separate pieces,
to give a total tolerance
of 1/16-inch upon assembly.

Tests found the weld structure perfect
and analysis as predicted.

If you have tough welding problems,
call your Lincoln Welding Engineer, today!

THE LINCOLN ELECTRIC COMPANY • Dept. 1760 • Cleveland 17, Ohio
The World's Largest Manufacturer of Arc Welding Equipment

LINCOLN

GOLD STAR SR

This d-c rectifier type welder does more things better than any other welder of its class because —

a. Its new transformer (Miller designed and built) has integral flux diverter.
b. Its new weld stabilized circuit delivers the ultimate in speed of metal deposition.
c. Its new completely sealed semi-metallic rectifier — designed for welding — provides the most efficient d-c for welding ever devised.

These features contribute to the Gold Star SR's greater arc stability, denser welds, easy arc starting and flexibility to handle all electrodes in all positions.

Performance-proved wherever profits are important, the Gold Star SR is available in single and duplex models of 200 to 1200 amperes at 60% duty cycle ratings.

" . . . if it's MILLER
you know it's the finest . . ."

GOLD STAR *All-Weather* SRH

The features that set the SR above and beyond the normal standards of welder performance belong to the SRH also. But, in addition to the horizontal design for easier stacking and paralleling, this welder has an "all-weather" construction that includes baked varnish coated transformers and rectifiers plus phosphatizing and painting of all base and sheet metal — even fan blades. Cam-Lok receptacles are standard equipment. The Gold Star SRH welds real well.

Complete specifications on these Gold Star models will be sent promptly.

miller Electric Manufacturing Company, Inc., APPLETON, WISCONSIN

EXPORT OFFICE: 250 West 57th St., New York 19, N.Y. • Distributed in Canada by Canadian Liquid Air Co., Ltd., Montreal

BETWEEN PASSES

mining the sea

A revolutionary method of extracting metals from the sea has been invented by Professor Felix Sebba of Witwatersrand University, Johannesburg, South Africa. Armour & Co., Chicago, under rights it has acquired, has filed patent applications in the United States and some 31 other countries on this low-cost process, although it has not yet reached commercial application.

Sebba uses a "soap and bubble" method wherein certain soaps are said to chase the mineral to the surface of the sea after bubbles are blown through the water. The professor said the method would be capable of extracting 600 tons of aluminum per day, or 2 tons of uranium, or 240 ounces of gold. The mineral chased to the surface would depend upon the type of soap used.

set them straight

The primary purpose of this publication is to promote the use of the welding processes. It's a big job, and we are always glad for assistance. Welding has been maligned so often in advertising copy that we are sure we haven't seen all such ads. Anent this, *WE* recently received a copy of a letter sent to a small-boat manufacturing concern by R. H. Hoefler, chief welding engineer of Kaighin & Hughes, Inc., Toledo—a regular reader of (and sometime contributor to) WELDING ENGINEER. Ray's letter was prompted by this statement in some literature concerning a small aluminum craft made by the firm:

". . . welding is unnecessary and riveting is reduced 70%. This virtually eliminates the possibility of leaks because most boat leakage occurs where *welding* or riveting has caused a reduction in tensile strength or created the possibility of separation."

To which Ray answered:

"If you intend to sell your boats to men of today's industry, I recommend that you bring your thinking and fabrication techniques up to 1959 standards. A properly made aluminum weld will be stronger than the base metal, while rivet holes will lower the tensile strength. Why do you make a one-piece seamless hull, punch it full of holes, and then attempt to close those holes with rivets?

"It is obvious that your organization could use some up-to-date training in welding, so I am taking the liberty of enclosing an application for membership in the American Welding Society, wherein you may be brought abreast with today's development in aluminum craft construction."

strike losses

As of today (September 1), the steel strike has cost the oxygen and acetylene industry more than $100 million. The 47-day-old shutdown has caused the loss of 13,300,000 ingot tons of steel; the sales loss of 5.2 billion cubic feet of oxygen; and the sales loss of 1.9 billion cubic feet of acetylene.

The estimated value of those gases not sold is $101,300,000.

the Bard

Shop condition: The engineers have reinforced it

. . . a rib of steel to make strength stronger

King Henry IV, Act II, Sc 3

weld it

Hobart Brothers Co., Troy, Ohio, now includes on its mailing envelopes a boxed legend that tells us, "If it's metal, weld it." This, along with a Hobart trademark, is imprinted by a postage-metering machine. We fully approve of this promotional device, because it is patterned after our "If it is made of metal, WELD IT!" The latter admonition is emblazoned on a large sign atop our publishing headquarters—the Welding Foundation Building.

30 years

A handsome 48-page brochure, entitled "The Miller Electric Story," commemorates the 30th anniversary of Miller Electric Mfg. Co., Inc., Appleton, Wis. Founded in 1929 by Niels C. Miller, who still is president, the firm is one of the largest producers of arc welding machines. The anniversary booklet pictures every employee of the Miller organization, and describes each department. All in all, it is more of a story about the people that make up Miller, rather than a story about a machine or a physical plant. And much, if not most, of the credit for this remarkable publication, we are told, goes to the firm's advertising manager, Gib Waldron.

switch in positions

After 19 years as editor of WELDING ENGINEER, Ted Jefferson has relinquished that title. Ted has filled the dual position of editor-publisher since Jan. 1, 1955, and, of course, will continue as publisher. Felix (Fel) Tancula, executive editor since 1955, succeeds him as chief editor. Greg Cannizzo has been moved up to managing editor. He replaces Jack Fairlie who left to join a public relations firm. Ken Rhodie, news editor since mid-1958, has been promoted to associate editor.

Titeflex, Inc., Meets Aircraft Fuel, Lubrication and Hydraulic Line Specifications with

HANDY & HARMAN BRAZE 541

Titeflex operator brazes assembly with torch and hand-fed Handy & Harman Alloy BRAZE 541. *Titeflex is unique in that it makes flexible hose assemblies from raw material to end product—"From End to End, Inside and Out, made RIGHT In Our Own Plant."*

This Springfield, Massachusetts, manufacturer of aircraft and missile fuel, lubrication and hydraulic lines finds that silver alloy brazing with Handy & Harman BRAZE 541 meets rigid operating requirements "all the way down the line."

The tubing and fittings of many of the wide range of assemblies made by Titeflex are 321, 316 and 347 stainless steel and Monel. Brazing is a hand torch, wire and HANDY FLUX operation.

BRAZE 541 is a plastic alloy which melts at 1325° F and flows at 1575° F. Its strength—in shear—at elevated temperatures is 21,500 psi at 500° F and 15,000 psi at 750° F. This alloy's ductility in resisting stress and vibration is very high and its resistance to oxidation and corrosion is equally impressive. The composition of BRAZE 541 is 54% silver, 40% copper, 5% zinc and 1% nickel. It meets AMS Specification 4772.

Aircraft and missile component manufacturers and fabricators are finding—to their and their products' benefit—that Handy & Harman silver alloy brazing is the full and *final* solution to their metal-joining problems. BRAZE 541 is but one of a large family of Handy & Harman alloys, for both low and high temperature applications. We would like to more fully acquaint you with BRAZE 541 and with the advantages that come naturally to silver brazing as a metal-joining (both ferrous and nonferrous) method. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

Your No. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

Offices and Plants
Bridgeport, Conn.
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save!

Push the button—and save up to 10% on oxygen costs, up to 30% on fuel gas costs . . . with SMITH'S money-saving push button gas control unit! Two additional advantages: it saves on labor costs—16% in a typical case history . . . also improves cutting quality by reducing burnover; improves welding quality by reducing pinholes and slag inclusions and gives better puddle control. SMITH'S gas control unit instantly reduces the high pre-heat flame you need to start many cutting, welding, silver soldering, production brazing, and heating operations to the lower flame you need to complete them. Makes an ideal shut-off valve for inert gas welding, heavy heating and flame hardening equipment. It works on a solenoid-operated valve, plugs into any 110 volt outlet. Use with as many as 8 machine torches (pays for itself over and over again). Available with either hand or foot operated remote control for maximum convenience. See your welding supply distributor, or write:

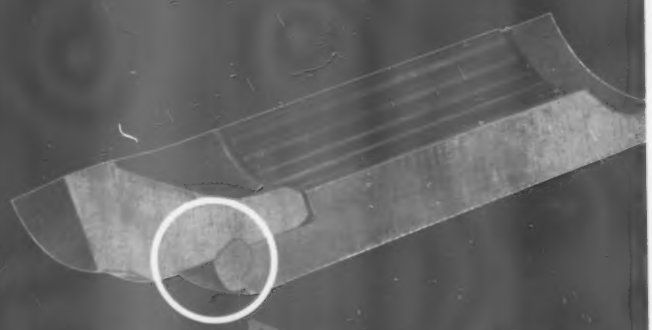
PUSH-BUTTON GAS CONTROL

SMITH WELDING EQUIPMENT CORPORATION

2623 Fourth Street S. E.,
Minneapolis 14, Minn.

NEW WIRE

WELDS TWO HIGH-CARBON RESULFURIZED STEELS



Now You Can Weld SAE 1141 to SAE 1151----with CO_2 and

PAGE A-S-18

The cutaway portion of a drive shaft shown above was produced on an automotive production line. It consists of two welded pieces of high-carbon, sulfur-bearing steel—SAE 1141 and SAE 1151. Note the clean metal in the weld.

Previously, it has been impractical to weld these grades of steel by inert gas or submerged arc methods. Pre-heat and post-heat normally were required resulting in the annealing of the pre-hardened sections of the steel.

New PAGE Analysis A-S-18 solves this problem. Using PAGE A-S-18, without pre-heat and post-heat, you can obtain a high-quality, non-porous weld on any free-machining steels in the SAE 1100 series, or on any .25 to .50 carbon steel. For instance, .35 carbon steel joints welded with A-S-18, using CO_2, produced tensile strength of 75/81,000 p.s.i.—yield strength of 55/61,000 p.s.i.—elongation of 24%.

PAGE A-S-18 may be an answer to your welding problem. Why not try it?

A portion of a drive shaft shows perfect weld around circumference, a result of high elongation of PAGE A-S-18. The weld was accomplished in two passes.

Let PAGE Help Solve Your Welding Problems

These Folders can help you

Write for:

Folder DH-402-C Contains information on submerged arc and inert gas automatic welding wire. Lists descriptions and uses of the many PAGE analyses. Describes our extensive variety of packaging. Illustrated.

Folder DH-1218 • Chart lists detailed analyses of PAGE automatic welding wires, metal spray wires, bare electrodes and gas welding rods. Shows uses and physical properties. Lists most competitive makes.

When you bring your welding problems to PAGE, you get the benefit of over half a century of wire drawing experience and leadership in metallurgical research. Leadership evidenced by the industry's widest range of analyses —33 grades designed to do an endless variety of welding jobs. Let PAGE help you improve your quality and lower your costs by furnishing the right wire for your job.

PAGE wire packaging is designed to give you the utmost in convenient storage and handling, whether you require a 1# spool or a 1200# payoff-pallet. Prompt delivery is assured from a coast-to-coast network of PAGE distributors backed up by strategically located PAGE warehouses.

You will find it is "good business" to bring your problems to PAGE.

ACCO

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Page Steel and Wire Division • American Chain & Cable Company, Inc.

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*Indicates PAGE warehouse stocks

PAGE—THE SOURCE FOR ANSWERS TO WELDING PROBLEMS

SEPTEMBER, 1959

Welding Engineer

ESTABLISHED 1916

Obsolete before he starts

SEVERAL TIMES DURING JULY, a recent graduate of one of the Midwest's largest engineering schools came to our Morton Grove offices. *He is engaged in a do-it-yourself welding engineering course apparently because of a sad state of affairs in our engineering schools.*

As this do-it-yourselfer stated: "I graduated in civil engineering and didn't learn much about welding. Maybe ME's learn a little more; I don't know. They gave us a lot on rivets, but nobody seems to use them.

"One place in Pittsburgh, where I nearly went to work, builds all kinds of things from steel, but they weld everything. The same is true of the tank company I am now working for. They haven't riveted anything for years."

If we don't rivet pressure vessels, why do our engineering schools persist in teaching students how to design them?

Educators claim the fault lies with the manufacturer, who does not advise them on the type of training the student should have. If this is the case, it's time manufacturers got together and wrote their specifications for what is desired in a graduate engineer.

It would also seem desirable for educators to spend their summers in industry discovering just how manufacturers do fabricate pressure vessels. Such activity would be more fruitful than a summer spent writing books on designing riveted pressure vessels.

Those manufacturers not obtaining properly trained engineering students should voice their complaints to the education committee of the Engineering Council for Professional Development, 25 West 39th St., New York 18, N. Y.

Tell them the kind of curriculum you feel your engineering employee requires. Maybe if enough of us do it, we will some day see engineers with the welding background industry so vitally needs. *Write now!*

Since April has been successfully launched as National Welded Products Month, perhaps September, traditionally the back-to-school month, should become Welding Education Month. We all know there is much more room for welding education; let's do something about it.

Preheating carbon-moly tubing with Victor Model J27 torch and Type 28 heating nozzle at Besler Corp., Emeryville, Calif.

The man on the job likes Victor torch flexibility

Flexibility is built into all Victor torches, regardless of size. Here, for example, Series J torches are being used to preheat, then weld ⅝" O.D. with .095" wall tubing for steam generators. With a change of nozzles and tips these same torches braze and solder . . . with the addition of a cutting attachment, can be used for light cutting applications and ocasional short jobs up to approximately 2" steel.

Victor Series 100 torches for medium-duty work and the famous Series 300 for tough, heavy work, give you this same flexibility . . . heating, welding, brazing, soldering, cutting. All 3 sizes, with proper cutting attachment, can be used with oxygen-acetylene, oxygen-propane, oxygen-city or natural gas.

Ask your Victor dealer for a demonstration now. You'll see for yourself how Victor torches answer all your welding and cutting needs.

Welding ⅝" O.D. with .095" wall tube into generator coil, using Model J27 torch and Type 17 welding nozzle with oxy-acetylene.

Profitable dealerships open in a few areas; inquire now.

VICTOR for welding and cutting

VICTOR EQUIPMENT COMPANY

Mfrs. of welding & cutting equipment; high pressure and large volume gas regulators; hardfacing rods, blasting nozzles; cobalt & tungsten castings; straightline and shape cutting machines.

62

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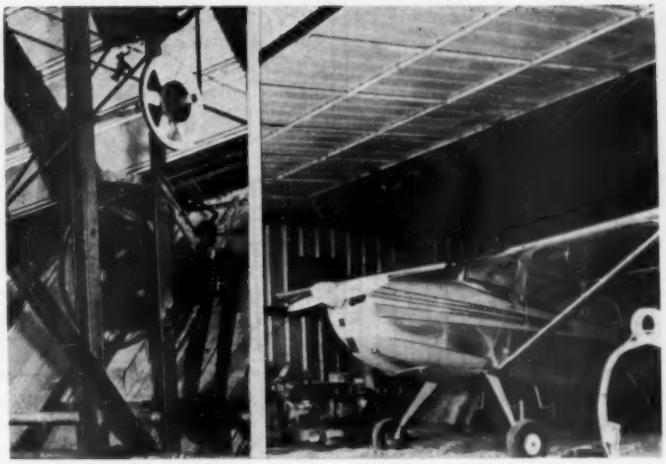
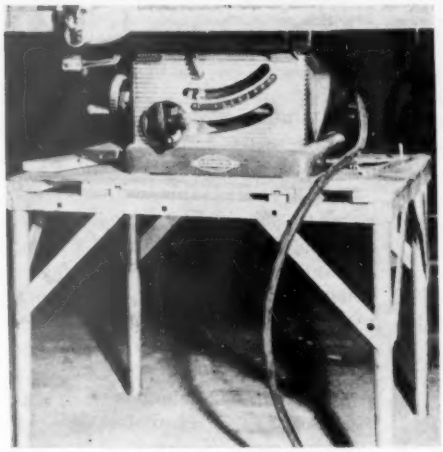
J. C. Menzies & Co., Wholly-Owned Subsidiary

WELDING is an aid to farming, just as it is to any other large industry. Illustrated here are some farm items made possible by welding. Full-width metal door and walls of this 40-ft commercially built shed are of welded pipe framing covered with metal sheets. One-piece door weighs 1,200 lb, and has been wind tested. Building houses farm machinery and airplane Jeff Jennings of Columbus Junction, Iowa, uses in farm operations. At left is home-made lifting device which automatically raises door. A 1/4-hp electric motor powers an automobile transmission hooked to a shaft and belt-pulley. Door is on tracks supported by roof bracing. Transmission is started by wall switch, and raises door by means of chains attached to pulleys, in turn attached to pipe-winch arrangement above door



by A. M. Wettach

Welding aids farmer . . . in his work . . .



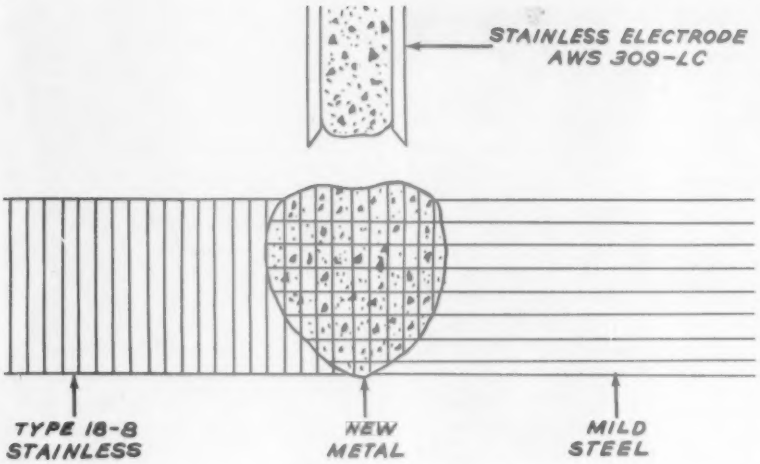
IRON pipe, flat and angle irons were welded to make this handy, strong and easily moved saw table. Ray Creelman uses it on his Oakville, Iowa, farm.

A combine hopper welded to angle irons makes up seeder-fertilizer spreader-trailer. Unit is mounted on car axle and attached to tongue so it can be pulled by tractor. Spreading is powered by tractor take-off unit connected through shaft under hopper opening. Pulley and V-belt, also connected through shaft, are used to operate end-gate seeder. Milk can beside hopper feeds seed through flexible spout into seeder while fertilizer is fed in from hopper slide. Kermit De Haai, Monroe, Iowa, devised unique farm aid.

and at home . . .

SCRAP metal was put to use at home of H. Schleif of West Point, Iowa. This ornamental iron post holds two mail boxes and brackets for packages. Farm shop and garage were sources of scrap. Base is truck brake drum, posts are of angles and flat irons.

SCRAP material usually found around farm was used to make this ornamental iron railing. Complete unit slips over iron pipes set in concrete when porch was poured. Joe Jackson of Galveston, Ind., made railing for his home.



COMBINATION of the chemistries of the two base metals and the filler metal make up the chemistry of the weld, which differs from any of the three original metals.

How to get better stainless steel welds

by **W. L. Wilcox**
Arcos Corp., Philadelphia

WELDING has long been considered an art. But in recent years, it has actually become more of a science—particularly in its application on stainless steels.

These steels are wonder metals of our time, not just because of their strength, toughness and stainless qualities, but also because they retain these properties at temperatures ranging from —450 F to as high as 2,000 F. The range of possible uses created by this versatility obviously prompts a demand for greater-than-usual welding skill.

The care taken by a skilled weldor, plus electrode quality, are undoubtedly the most important of many factors known to contribute to sound, serviceable stainless welds. But what of the *unknown* factors? Do they pose a serious threat to that portion of industry which constantly welds many types of stainless steel?

The answer, fortunately, is *no.* Even though each stainless welding job poses its own problems, there are certain basic fundamentals which apply to the welding of *any* stainless steel. To know these fundamentals, and to put them into constant practice, is to create the difference between success or failure on any job.

But before delving into welding techniques and electrode selection, let's discover just what is meant by the term *stainless* steel.

Chromium is the metal which, when added to steel, makes it stainless. The minimum chromium content required to impart a stainless quality to steel is approximately 11.5%, so all steels containing more than this amount of chromium are termed *stainless* steels.

A stainless steel may or may not contain nickel: those which do are generally non-magnetic and are termed *austenitic* types. Those steels which do not contain nickel or a reasonably high percentage (15 to 20%) of manganese are highly magnetic and are termed *ferritic* stainless. By using a magnet, it is easy to distinguish between those stainless steels that contain nickel and those that do not.

Austenitic stainless welds, though they contain nickel or a considerable quantity of manganese, may sometimes be strongly attracted by a magnet. This attraction is produced by the *ferrite* in the weld. It is this magnetic structure in a balanced weld that helps it resist cracking.

Classification of stainless welding electrodes is generally based on *(1)* weld deposit chemistry, and *(2)* the welding current for which they are best suited. (Whether an electrode will operate on a-c or d-c or both is a factor dependent on coating characteristics.)

Stainless coated electrodes may belong to the 200, 300, 400 or 500 series, depending on the type of weld metal deposited. This is the steel-makers' method of designating chemical composition, and it is used by electrode manufacturers as part of their standard designation. Differences within a series, as well as between each series, lie in chemical composition.

The 200 series stainless steels contain about 18% chromium and approximately 3% nickel. This metal type is generally welded with a 300-series electrode. Type 202 and 204 stainless, for instance, would be welded with a type 308 electrode. The 200-series steels can be welded without heat treatment, and will have good strength and ductility in the as-welded condition.

The 300 series stainless base metals and electrodes contain large amounts of chromium, and medium-to-large amounts of nickel. This group is generally easy to weld and does not require preheat. Postheat, however, may be required *(1)* to restore corrosion resistance or other properties to base metal after welding, or *(2)* to decrease ferrite content of weld metal when required.

The 400 series contains large amounts of chromium (11.5% to 28%) and these steels are frequently called "straight chromes." This group

usually requires preheat to prevent cracking during or after welding, and postheat to remove hardness encountered during cooling and to restore ductility.

Electrodes in the 500 series contain 4 to 6% chromium and smaller quantities of molybdenum; they are often called "chrome-moly" types. Other steels and electrodes containing up to 3% chromium and 1% moly are available, but are considered low-alloy steels—even though they are also commonly referred to as chrome-moly types.

The 500 series, like the 400 series —also needs pre- and postheat treatment to avoid cracking and to develop its best qualities.

A standard color coding or color marking system is used for identification of single electrodes. Three different colors—which, depending on location, are termed *group, end* or *side* colors—are painted on each coated stainless electrode. Each color, in combination with the other two, has a particular meaning.

The *group* color, painted on the coating as a dot, indicates type of current to be used with the electrode. Black is for d-c; yellow for a-c/d-c. *Spot* and *end* colors painted on the bare core wire indicate the type of weld metal the electrode will deposit *(see table)*.

Color coding for stainless electrodes is under the supervision of the welding section of the National Electrical Manufacturers Association, and is known as the NEMA Standard for Electrode Identification.

The numbering system set up by the American Welding Society is another widely-used method of identifying electrodes. In a number designation for stainless types, the first three digits indicate electrode composition; the last two, separated from the first three by a dash, indicate type of welding current to be used.

In the E308-15 designation, for example, *E* means *coated electrode; 308* indicates the *18% chromium, 8% nickel composition,* and the *—15* means this electrode coating is designed for use with d-c.

The coating on a stainless welding electrode serves these important functions:

1. It shields the arc during welding by melting and forming a gas (CO_2) that keeps oxygen in the air from contacting the molten pool and forming undesirable oxides.

2. It promotes arc smoothness by burning off more slowly than the electrode's core wire, forming a small cup at the tip of the electrode which makes arc control and direction easier.

3. It forms slag which protects the weld from air during cooling and keeps heavy oxides from forming.

4. It alloys with weld metal to improve its soundness by controlling cracking and porosity.

Moisture in a stainless electrode coating may cause the coating to pop, or to impart porosity to the weld metal. Electrodes too moist for safe welding use (and the danger signal may well be given as a coating explodes during welding) should be dried by baking at 350 to 400 F for a few hours before using.

Weld porosity caused by moisture in the electrode coating can structurally weaken the weld and damage its corrosion resistance. Always be sure that stainless electrodes are carefully packaged and stored.

When low-alloy, high-strength steels were introduced about 1940, the cellulose in the coating of mild steel electrodes used to weld them caused underbead cracking. This phenomenon is best described as the tendency of a weld to lift out of, or separate from, base metal.

Hydrogen in the cellulose and moisture in the coating are to be blamed for this cracking. During welding, hydrogen is released and accumulates in molten metal. When weld and base metal harden during cooling, hydrogen exerts a crack-causing pressure in attempting to escape.

This underbead cracking is especially severe in higher-carbon or higher-strength low-alloy steels (those above 0.015% carbon or above 100,000 psi in strength). The problem can be solved by applying a mineral or stainless coating (free from cellulose) to the low-alloy steel electrodes.

Any moisture present in the coatings during manufacture is driven off by applying high temperature baking for long periods. With the hydrogen source eliminated, these electrodes become low-hydrogen.

"Fingernailing" is a condition occurring when the electrode coating burns off more rapidly on one side than on the other, making control of arc direction and bead shape difficult.

This may be due to the coating being thicker on one side (*i.e.*, eccentric), or to magnetic disturbances around the arc which draws it to one side of the electrode. (When this happens, the coating will melt faster on one side and is called magnetic arc blow. It occurs only when using d-c current.)

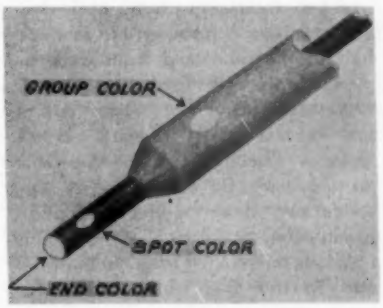
Several steps can be followed to control magnetic arc blow:

1—Change the ground connection to another location.

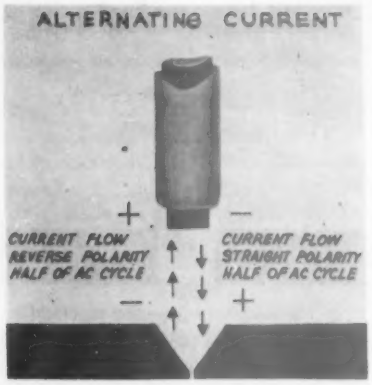
2—If possible, wrap one lead around the section being welded.

3—Tilt the electrode so that the heat and metal deposit are concentrated where wanted—or so that the

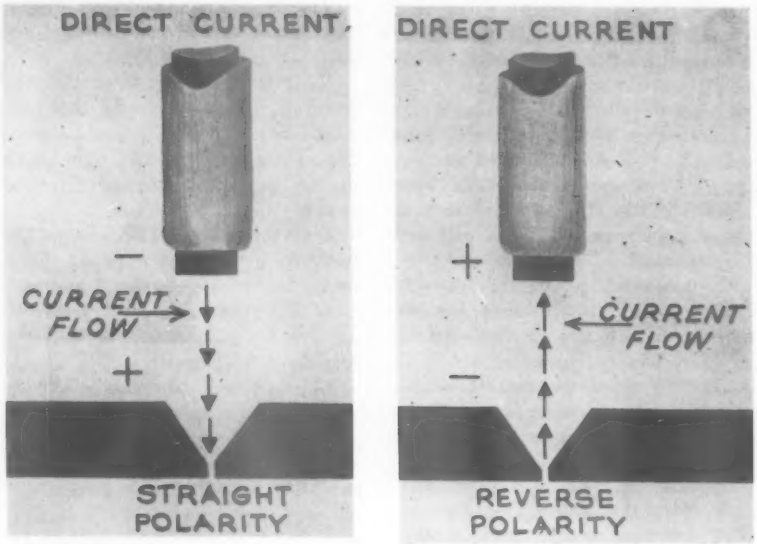
STAINLESS STEELS	END COLOR	SPOT COLOR	GROUP COLOR	
			DC	AC-DC
308ELC	Brown	None	Black	Yellow
316ELC	Brown	White		
330	Green	None		
312	Green	Red		
310	Red	None		
310Cb	Red	Blue		
310Mo	Red	White		
308	Yellow	None		
347	Yellow	Blue		
316	Yellow	White		
317	Yellow	Brown		
309	Black	None		
309Cb	Black	Blue		
309Mo	Black	White		
502	Gray	Blue		
505	Gray	White		
410	Gray	Brown		
430	Gray	Green		
442	Gray	Red		
446	Gray	Yellow		



COLOR coding for stainless electrodes is divided into group, spot and end designations. Each color, combined with the other two, has a particular meaning.



EACH second of a-c contains 120 moments of no current flow, causing an unstable arc, more spatter and poor penetration when welding stainless.



CURRENT flowing in one direction (d-c straight or reverse polarity) eliminates disadvantages of a-c, and provides faster welding and better appearance as well. Reverse polarity is preferred for welding stainless steel.

electrode is pointed back toward the weld deposit.

4—Decrease the welding heat.

Electrode selection for each stainless job is extremely important. Unless the proper selection and use is made, welded joints may fail, and a poor stainless weld can cost thousands of dollars.

Stainless is used where material must take abuse of one kind or another, and requires costly alloys and unusual care—hence its high cost. A poor weld, or the wrong weld metal, can result in much costly chipping and rewelding, or a total loss.

Generally, d-c reverse polarity is more satisfactory than a-c when welding stainless. There are two points to keep in mind when determining why; one involves current characteristics, and the other is an effect of the electrode coating.

When welding with 60 cycle a-c, current flows from electrode to work half of the time, and from work to electrode the other half. Each second there are 120 moments when there is no current flow (when current changes direction). This stop and go characteristic results in an unstable arc, more spatter and poor penetration.

When current is made to flow in one direction from work to electrode, as in reverse polarity, these disadvantages are eliminated and faster welding and better appearance are gained as well.

To create a smooth arc with a-c requires certain materials added to the electrode coating, such as titania (TiO_2). However, experience has shown that these materials produce weld metal more sensitive to cracking than that of lime-type d-c reverse polarity electrodes.

When welding any stainless, a stringer bead technique is better than a weaving one. For the best corrosion resistance, the base metal's overall temperature should be kept as low as possible while allowing as rapid a cooling as possible from welding temperatures.

The weaving technique may put considerable heat in a small area in a given period, reducing base and weld corrosion resistance in the weld area, as well as promoting serious cracking. Stringer beads, however, keep heat input low and bring out the best qualities of welded stainless steel.

When dissimilar steels are arc welded, portions of each are melted and contribute to the weld metal chemistry. The combination of these chemistries (two different base metals and the filler metal) make up the weld chemistry, which will differ from any of the original metals.

To obtain a sound, serviceable joint, it may be necessary to use an electrode containing considerably larger amounts of alloying elements than either of the base metals.

"Why isn't there one all-purpose stainless electrode?" This question is often asked and the answer can best be obtained by considering the approximately one dozen elements (chromium, nickel, manganese, molybdenum, etc.) which give special qualities when added to steel.

Chromium, for example, builds corrosion resistance, as does nickel, which also prevents hardening of base metal and weld metal during cooling when in sufficient quantities. Manganese adds strength and reduces cracking, while molybdenum increases corrosion resistance to sulfuric acid and increases the strength at high temperatures. Other alloys make different contributions.

One electrode cannot be designed to match all the properties imparted by all these elements, any more than a single grade of base metal can be designed to satisfy all of today's diverse requirements.

[*Ed. note*—Some authorities might disagree with the author. For more information, see *Welding dissimilar metals*, WELDING ENGINEER Fact File, p. 5.]

To find the right electrode for a given operation, the general rule is to select an electrode which will produce weld metal of the same chemistry type as that of the base metal.

There may be times, however, when an electrode of a different composition should be selected. But in all cases, proper electrode selection and its use is as important as any other factor to be considered.

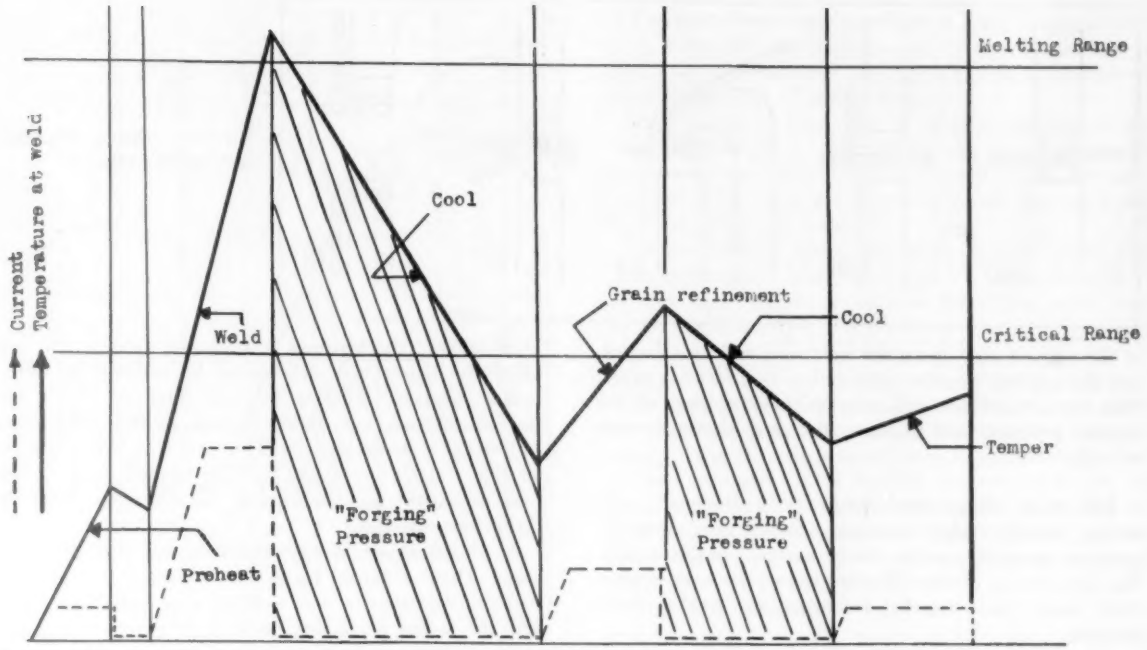


FIG. 1—Schematic diagram of a spot welding schedule for moderate to high hardenable material.

Part I

Spot welding procedures and design

by **Lester F. Spencer** . . . *Metallurgical Engineer*

SPOT WELDING IS THE PROCESS of joining two or more overlapping sheets by local fusion of a small area.

Fusion of this area is obtained from heat produced by the material's resistance to the flow of electric current through the work parts, which are held in intimate contact under pressure by dome-shaped, copper-alloy electrodes.

Although the production of a spot weld, either as a single or multiple weld pattern, is obtained in a few seconds, the weld cycle may be divided into four phases:

Squeeze time—the interval between application of tip pressure to the work and application of a welding current;

Weld time—the interval in which welding current flows through the circuit;

Hold time—the interval during which pressure is held constant after the welding current has been discontinued;

Off time—the interval required for transfer of the work from the completed weld to a new location where the above cycle is repeated.

In some cases, particularly when high or moderate hardenable material is spot welded, there may be three additional steps; preheat, grain refinement and temper.

The popularity of spot welding is based not only on its economy, but also on minimum metallurgical disturbances in its weld areas. However, success—measured by weld shear strength, as well as shear strength consistency—depends on several factors, which shall serve only as guides in this article.

Since there is a direct relationship between weld strength and joint design, the latter assumes considerable importance in obtaining satisfactory joints.

Joint accessibility is the first factor to be considered. All joints must provide sufficient clearance for standard electrodes and holders. Special horn and electrode shapes may be required at times, but these are usually high in first costs, as well as increased maintenance.

Figure 2 is an analysis of joint types for spot welding. The widely used lap joint *(a)* can be produced on any type machine; flange joints *(b)* are ordinarily accessible, but where the vertical leg is high, placement and removal of material may be difficult. The joint shown as *(c)* is not desirable because of the confined area for the upper electrode. However, a satisfactory weld can be made with a portable gun-type welder.

The sandwich joint *(d)* should also be avoided, since a considerable amount of current passes through the outer sheet rather than the joint. The flanged stamping spot welded to a tube *(e)* is satisfactory, provided the tube has sufficient strength to resist collapse.

Another factor associated with joint design is tolerance of component parts to be welded. Spot welding has little or no effect on part tolerances since it actually adds no metal. However, it is generally recommended that tolerance of assembled parts should be held as close as possible.

Poorly formed or buckled parts may cause shunting

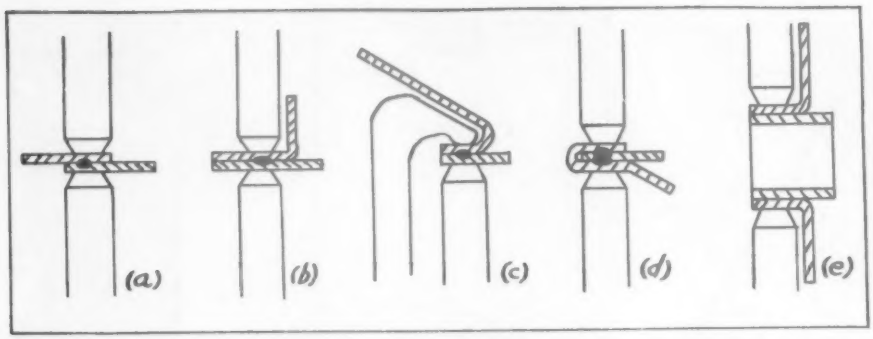


FIG. 2—A selection of typical spot welded joints.

of the current away from the weld, and will also necessitate the welding machine performing as a forming press. This latter condition will rob the weld of part of the applied pressure, and produce increased electrode wear as well.

Electrode shape and design; tip diameter; contacting overlap; edge distance; spacing; etc., may be grouped generally under basic design considerations. The importance of these factors cannot be over-emphasized since they directly influence the weld's shear strength.

Whenever possible RWMA standard Morse tapered electrodes should be used. Pointed tips are widely utilized since, with continued wear, they mushroom uniformly without changing the contact area.

Domed tips (used for spot welding many non-ferrous materials, coated steels and, in some cases, heavy gage material) are characterized by easy cleaning and their ability to withstand heavy pressure and severe heating without mushrooming.

Where "invisible" or inconspicuous welds are desired, or where weld indentation must be minimized, a flat tip electrode is normally used. In this case, the flat tip is applied to the sheet where weld indentation must be at a minimum, whereas domed type electrodes are placed against the other sheet.

The offset tip is used for corner welds, parts with overhanging flanges, or to produce welds in less accessible areas. The amount of practical offset is limited to the force required, as well as the strength and rigidity of the holders. One difficulty encountered with use of this type electrode is part slippage (with consequent distortion and poor quality welds) because of any appreciable deflection.

In determining the diameter of a flat tip electrode, the formula $0.1+2t$ (where "t" is thickness in inches of the sheet contacted) is frequently cited. This formula has been found satisfactory for low carbon material (SAE 1005 to 1020) from 0.005 to 0.0125-in. thick.

When welding thin material to thick material, where no marking is permissible on the heavier stock, the flat electrode diameter used against the heavier stock is calculated for the thinner material, *e.g.*, 0.050 in. welded to 0.125 in., calculate as $0.1+ (0.050+0.050)=0.20$ in.

On the other hand, if thick material is welded to thin material when the large electrode face is on the thin sheet, diameter is calculated from the heavier material, *e.g.*, 0.125 in. welded to 0.050 in., calculate as $0.1+ (0.125+0.125)=0.35$ in.

If three thicknesses are to be welded, the flat electrode diameter is determined by adding the thicknesses involved, dividing by two, then calculating for two thicknesses, *e.g.*, 0.050 welded in triple thickness *(1)* 0.050 x 3, divided by 2 = 0.075 in.; *(2)* $0.1 + (0.075 + 0.075) = 0.250$ in. (The formula $d = \sqrt{t}$ has been suggested in determining flat electrode diameter for heavy material.)

As stated above, domed and flat-faced tips are combined. Thus, a domed tip is used to obtain a high current concentration in spot welding aluminum-base alloys with the radius depending on both alloy type and structural condition, as well as stock thickness.

(A general recommendation, applicable regardless of the material being welded, is that a flat-faced electrode is used against the sheet requiring minimum indentation. and that tip dressing should be made either by machining or with a contour dressing tool to retain contour accuracy. A file should never be used.)

When spot welding magnesium alloys, tip radii of domed electrodes will vary from 2 to 8 in., depending on the sheet thickness.

With stainless steels, nickel and high-nickel alloys, a restricted, dome electrode is preferred to a flat, truncated cone electrode. A 3-in. radius is average for material up to 0.125-in. thick. However, a flat faced electrode, or one with a 5 to 8 in. radius dome, is frequently employed in stock thicknesses from 0.062 to 0.125 in., (resulting in a larger size nugget and correspondingly greater shear strength with a given machine setting).

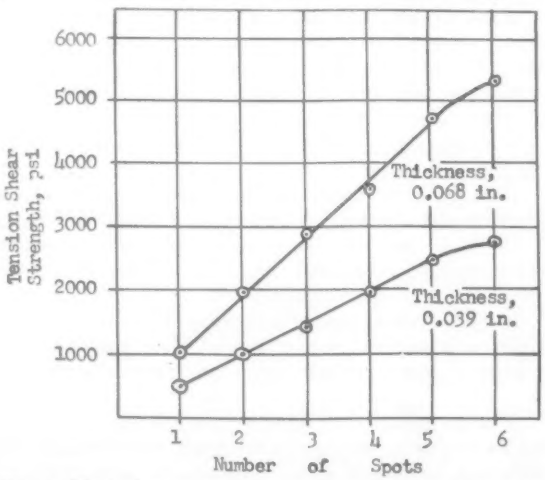


FIG. 3—Effect of increase in the number of single-row spot welds in an overlap joint on duraluminum.

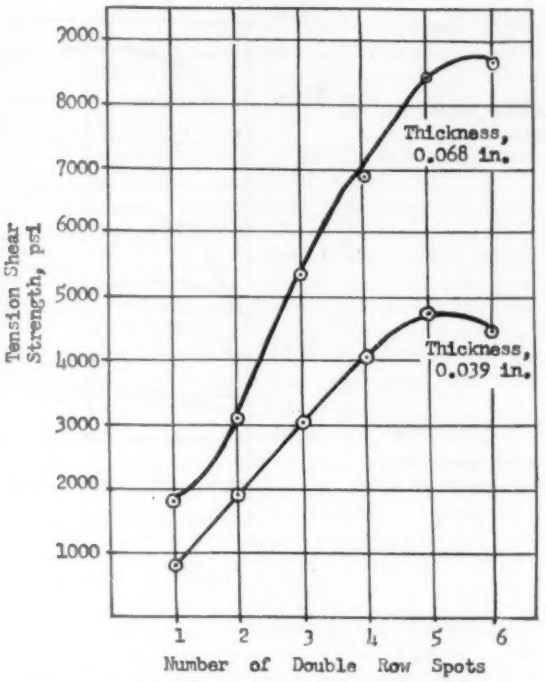


FIG. 4—Effect of increase in the number of double-row spot welds in an overlap joint.

Cone angle will vary with the initial material hardness. Softer grades, usually in the annealed condition, require an angle of about 10 deg; harder alloys will use an angle as high as 30 deg.

Enough flat overlap must be provided to contain the spot weld, and minimum overlap will vary with both material and gage thickness. Generally, however, overlap should equal the diameter of the weld nugget plus two times the recommended edge distance.

More overlap than needed may be slightly more costly in material, but will be easier for the operator in locating the spot weld (usually done by sight). Less than the recommended overlap will cause slower welding, since the operator must locate his spots more carefully.

In addition, metal expulsion will result and the weld will have low strength and possible porosity within the weld area, as explained below. Expulsion will also frequently require a finishing operation.

Another factor to consider is edge distance. For every sheet thickness there is a minimum distance which should be provided from the nugget's edge to the nearest point on the edge of either sheet.

The purpose of edge distance is to contain all of the fused metal within a spot. If the weld should be placed too close to an edge, molten metal will squirt out from the joint. This "edge expulsion" or metal loss will cause unsound and weak welds.

(When welding aluminum alloys, a spot placed too close to the sheet edge may bulge the metal because of its expansion forces. In extreme cases, the metal may actually split, causing a crack from the spot to the sheet edge.)

In an assembly where a succession of spot welds are placed within the same general area for increased strength, the distance between them should be maintained at the minimum value usually recommended for the specific material. Should the spot welds be located too close to each other, a large portion of the welding current needed for second or subsequent spot welds will shunt through previously made spots.

This may result in a relatively small nugget, or in extreme cases, no weld nugget at all. Thus, the initial good weld and the subsequent poor welds may not be strong enough to support the designated load.

For example, the stated minimum spot spacing for aluminum alloys has been placed at 8t, where "t" is sheet thickness. Should it be necessary to have spacing less than 8t, alternate procedures may include:

(1) Increasing the current after the initial spot weld has been made, in order to offset current lost by the shunting effect; or,

(2) Using two more rows of welds with spaces limited to 8t.

This latter procedure is preferred since it will produce welds 85-90% of the individual weld's strength. In joints of this design, failure usually occurs along the spot edges at joint efficiencies of 75-80%.

Of interest is the data presented by Stanley on the effect of increased single and double row spot welds in duraluminum. As illustrated in figure 3, an increase in spot welds, up to a limiting point, will materially increase shear strength. Figure 4 shows the effect of increasing double-row spot welds in an overlap joint. However, in both cases, the increased strength will not con-

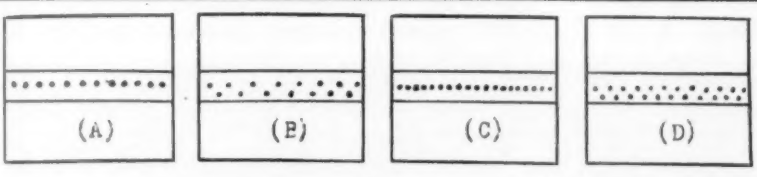


FIG. 5—Effect of spacing and pattern on multiple spot welds on 0.068 and 0.039 in. duraluminum.

	Type A	Type B	Type C	Type D	Gage, in.
Spot spacing, in.	0.750	0.750	0.500	0.500	
Tension shear strength of joint	10,160 lb	10,400 lb	12,700 lb	16,025 lb	0.068
Average shear strength per spot	848 lb	867 lb	707 lb	990 lb	0.068
Tension shear strength of joint	6,162 lb	8,530 lb	6,290 lb	9,147 lb	0.039
Average shear strength per spot	513 lb	481 lb	524 lb	517 lb	0.039

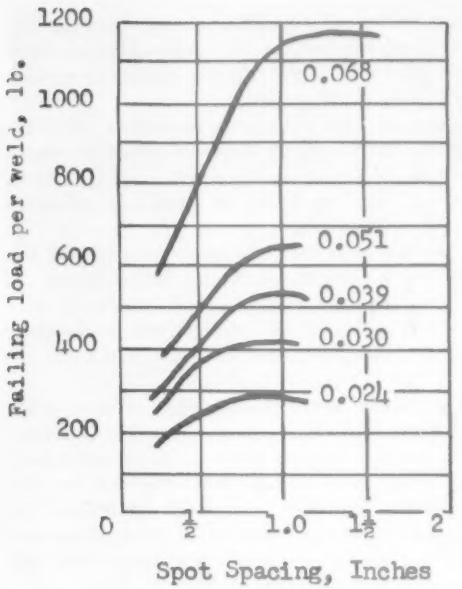


FIG. 6—Effect of weld spacing variation on static shear strength of Alclad.

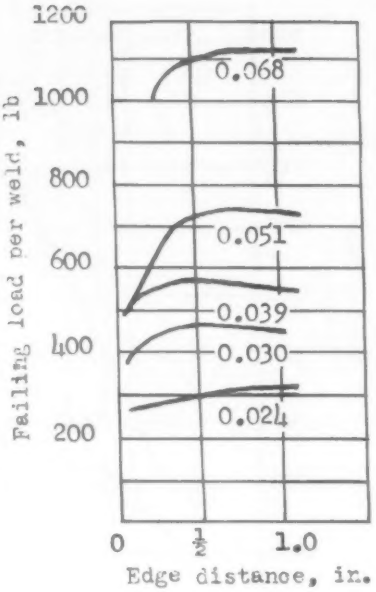


FIG. 7—Effect of edge distance variations on static shear strength of Alclad.

tinue beyond the strength of the unwelded strip, no matter how many spots are added.

Stanley also demonstrates the effect of consistent spot spacing with varied patterns of multiple welds on both 0.068 and 0.0391-in. duraluminum; the results are in figure 5. Data in this figure indicates a slight gain in strength may be obtained by a staggered weld pattern at the 0.068-in. thick level, utilizing a ¾-in spacing (joints A and B).

Reducing weld spacing to ½ in., the single row of spot welds (joint C) gains appreciable joint strength in welding 0.068 in. material, even though the average shear strength per spot has decreased. This increased strength is largely attributed to the increased number of spots (12 to 18) within the design.

Using a staggered design (joint D), a similar increase in joint strength, as well as average shear strength per spot, is realized. Thus, with the ½ in. spot spacing, a staggered pattern design is again superior to the single row of spot welds.

However, although increased joint strength results when changing to a staggered pattern when welding 0.0391-in.-thick material using both ¾ and ½ in. spot spacing, average shear strength per spot remains relatively constant. This indicates little gain when ½ in. is used in preference to ¾ in. spot spacings.

Analyzing the above, Stanley states: "Below a certain minimum spacing for a given thickness, the full strength of the weld will not be developed, as the sheet itself will tear. The minimum pitch increases with the gage of the sheet."

This relationship between static strength and weld spacing for five Alclad thicknesses is shown in figure 6. For example, if two welds were placed in a 0.039-in.-thick sheet with spot spacing at ¾ in., shear strength per spot would be about 300 lb, or a total of 600 lb for the two spots. Increasing the spot spacing to ½ in., single spot strength would be about 415 lb, an increase of 115 lb per spot.

Increasing spot spacing to ¾ in. in the same thickness, a strength of 500 lb is obtained, an increase of 85 lb. Further reduction in the "increased strength ratio" is realized when 1.0 in. spot spacing is used for the same thickness material. In this case, strength value is 530 lb, an increase of only 30 lb for a spot spacing increase of ¼ in.

Thus, strength per weld increases with widening pitch up to a limiting value according to material thickness. Above this pitch, for any one gage, weld strength tends to remain constant.

A similar relationship between edge distance and static strength of Alclad is shown in figure 7. Strength increases as the spot is located further from the edge, until a distance is reached where further removal does not afford any more strength increase.

As shown, a very pronounced change in strength is obtained in material thicknesses of 0.030 in. and up. The ideal edge distance for 0.030 and 0.039-in.-thick materials is ½ in., whereas for the 0.051 and 0.068-in. thick material, ¾ in. is best.

A relatively important factor (associated with weld design since it affects weld quality) is heat balance. Often this factor is not given due consideration, probably because of difficulty in predicting exact effects when welding dissimilar metals of equal or unequal thickness.

Heat balance has been defined as a condition in which fusion zones of both pieces to be joined undergo approximately the same degree of heating and pressure application.

When welding two dissimilar metals, the conditions listed below require evaluation in order to determine proper settings for current, pressure and time. These include:

(a) Relative thermal and electrical conductivity of the two materials to be joined;

(b) The difference in melting points of the two materials;

(c) Relative geometry of the parts to be joined;

(d) Resultant metallurgical reaction obtained in the weld joint (whether weld nugget and heat affected zone will be tough and ductile, or weak and brittle);

(e) The possibility of corrosive action within the joint due to electrolytic actions;

(f) Difference in plastic range of the two materials welded; and,

(g) Electrode types employed, their geometry, thermal and electrical conductivities.

An example of this evaluation is when welding a high conductivity material (high copper alloy) to a material of relatively low conductivity (stainless steel). The weld proper would not have high quality because of the poor alloying conditions of the combination. However, the nearest approach to production of a satisfactory weld would be by adopting one of the following:

(1) Using a smaller tip area on the copper alloy and a larger tip area on the stainless to equalize heat input by a variable current density;

(2) Using an electrode with a tungsten or molybdenum facing on the high conductivity material, and a normal electrode on the low conductivity material to realize approximately the same heat input; or,

(3) Using a combination of these two methods.

When welding low-carbon or corrosion-resistant steels (stainless and high nickel alloys) multiple thicknesses may be welded together. However, there are a number of restrictions that should be observed to obtain a satisfactory weld joint.

1—When the material is of equal thickness, any number of thicknesses may be welded provided the overall thickness of the stack does not exceed one inch.

2—In a combination of unequal thicknesses, where the outside sheets are thickest, the ratio between any two thicknesses should not exceed 3 to 1. Up to eight thicknesses may be welded, but overall thickness must not exceed one inch.

3—In a combination of unequal thicknesses, where the outside sheets are thinnest, the ratio between any two thicknesses should not exceed 2 to 1. Up to seven thicknesses may be satisfactorily welded, but again, overall thickness of the stack should not exceed one inch.

When spot welding non-ferrous materials in multiple thicknesses, restrictions are more stringent. Aluminum alloys in three thicknesses may be welded simultaneously, provided the total thickness of the stack does not exceed 5/16 in.

Since resistance of each pair of interfaces adds to welding pressure, both current and time setting (which depends on the alloy type of the outside sheet) will remain constant while an increased electrode pressure will compensate the increased resistance. When unequal thicknesses are spot welded, thickness ratio should not exceed 2 to 1.

With magnesium alloys, three thicknesses may be welded, provided the thickness of the stack does not exceed ¼ in. Where two unequal thicknesses are to be spot welded, the ratio should not exceed 2½ to 1 if maximum consistency and high weld strength are to be maintained.

When welding three thicknesses, each should not vary more than 25% of the others, and the thickest section should be in the stack center.

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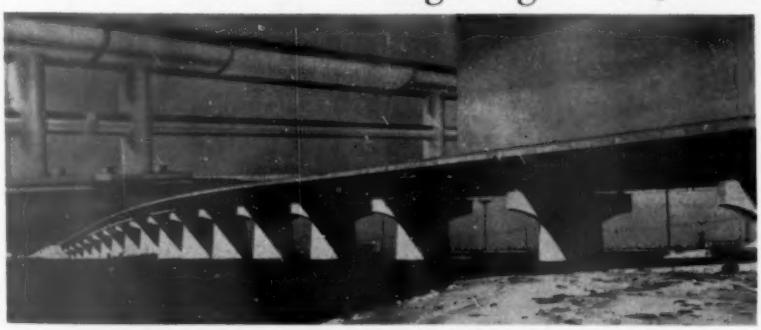
Welded aluminum railings "light" N. J. bridge



UNIQUE lighting fixtures on bridge, spanning New Jersey's Manahawkin Bay and connecting Ocean County mainland with Long Beach Island, are extruded aluminum railings. Top rung of the welded bridge-railing holds the lighting fixture and electrical wiring. Fabricated by Michael Flynn Mfg. Co., Philadelphia, for the 2,400 ft, $4.5 million bridge, the lighting system is safer for drivers; easier to service.

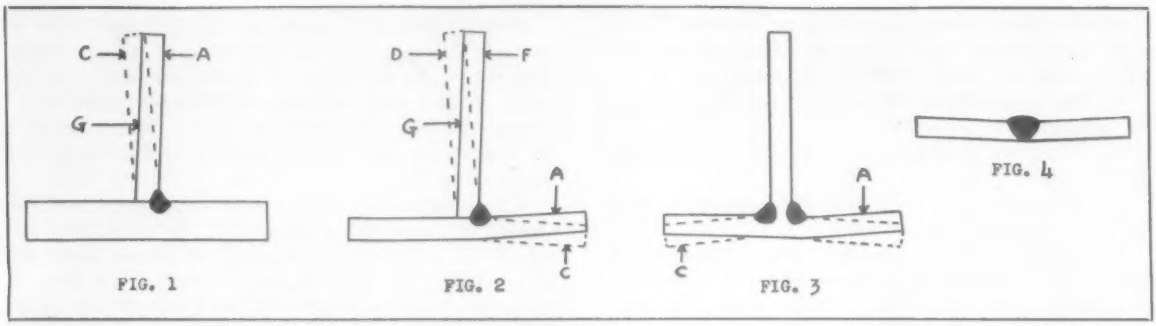


FIG. 1 FIG. 2 FIG. 3 FIG. 4

Understanding weld distortion and shrinkage

by **George W. Gardner**

MOST CAUSES OF DISTORTION and shrinkage can be determined if weld heat is first understood.

Weld metal in a molten state is at its largest size, and when cooled, contracts in three directions, the greatest being across the weld. Thus, residual stresses are set up, then offset by reaction stresses, which at times can equal the metal's ultimate tensile strength.

Amount of weld contraction is a variable factor depending on metal type and thickness, joint type, weld position, electrode type and welding method.

As metal contracts, the resulting stresses cause distortion both near and in the weld itself. (These stresses can also occur in preheating.) Differences in expansion and contraction of the heat-affected zone can cause distortion and shrinkage.

For example, if a bar of uniform size is evenly heated and cooled, no residual stresses appear and dimensions remain the same. A long bar, however, may distort due to rolling-caused stresses being released.

A bar 1-in. square by 2 in. long should remain straight while heated and cooled. But should the ends be restrained to prevent expansioin during heating, the bar will be shorter and possibly distorted after cooling has been completed.

Some of the contributing factors of distortion and shrinkage, therefore, are improper part and joint design, poorly located welds and incorrect welding procedures, any one of which can cause rework or uselessness of part or assembly.

Figure 1 is a Tee section made from a thick flange and a thin leg. The leg, originally located square, has moved to position A because of weld contraction. (If the flange is thick enough, it will not distort.)

Figure 2 shows a Tee section made from equal thicknesses. Here, in addition to leg movement to F, the flange on the weld side has drawn up as shown at A.

Figure 3 is a similar section welded, however, from both sides either solidly, or intermittently and staggered. This figure shows little, if any, leg movement if leg sections are located out-of-square (as in C and D, figures 1 and 2) and flange sections are prebent (as in C, figures 2 and 3). But again, the flange is likely to draw up at position A.

The fillet welds in the first two figures are weak if stressed in the direction of the arrows (G). On the other hand, welding from both sides, as done in figure 3, provides a strong weld. When used as an assembly stiffener, distortion can be reduced and adequate strength developed if welded intermittently, and alternately staggered from each leg side.

Using thinner sections as stiffeners, flanging and spot welding them will further reduce distortion. However, allow sufficient flange for proper placement of the spot weld. Wet asbestos close to the weld will also help prevent heat and the resulting distortion from spreading.

Figure 4 is a butt-joint, beveled and welded from one side, and neither restrained nor clamped down. The sections have drawn up, and

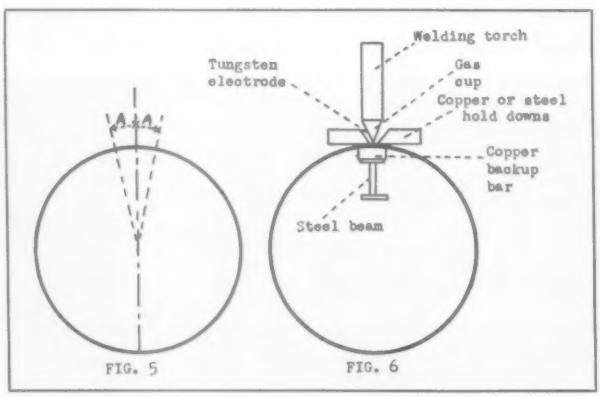


FIG. 5 FIG. 6

shrinkage lengthwise can cause warpage. Copper clamp-downs will help dissipate the heat and prevent distortion.

This weld type is widely used for parts or assemblies having to withstand pressure and rigid dye-penetrant, magnetic particle and radiographic inspection.

Using the least amount of heat consistent with weld quality, and confining it to the narrowest possible limits, will help prevent distortion. Wet asbestos will also help again.

When manual Tig welding, parts up to ⅛-in. thick require no beveling, while ⅛ to ¼-in. parts have a 45 deg chamfer with a slight flat or land at the bottom. For joints thicker than ¼ in., a U-groove with a 1/32 to 1/16-in. land will provide the best results.

The included angle need not be more than 60 deg, with a 70 deg limit. This joint type will use considerably less heat and, in turn, cause less distortion than a conventional 90 deg Vee-joint. Even though more expensive, it is really more economical since electrodes are saved and an efficient joint base is provided.

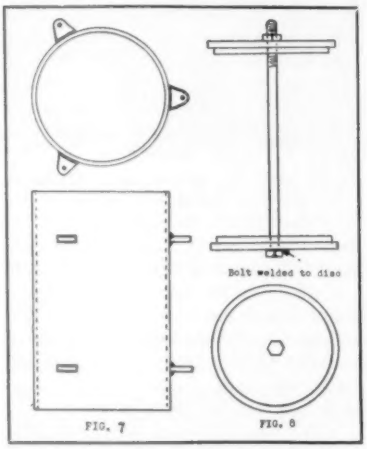


FIG. 7 FIG. 8

If a Vee-bevel joint is used, a good first pass will be difficult since the Vee sides must be melted and full penetration is not always assured. In a U-grooved joint, however, the gas cup has more room and edges can be more easily fused.

This is particularly important on thicker joints where the groove should be wide enough for proper fusion at the bottom, as well as good penetration.

As succeeding passes are made, shrinkage and (depending on part or assembly type) distortion will occur. The least amount of shrinkage and distortion occurs with manual metal-arc welding.

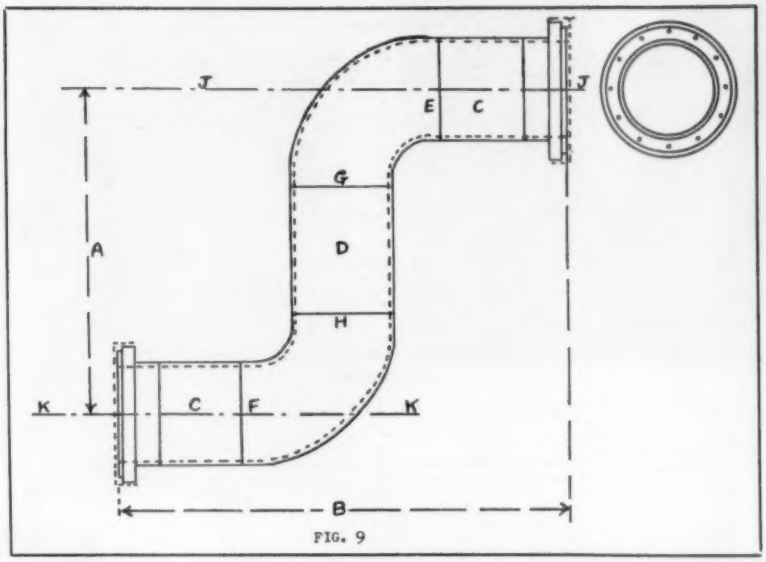


FIG. 9

Planishing machines are excellent for improving weld appearance and removing locked up stresses. Peening is also used, but due to the work-hardening properties of some alloys, its use is questionable. Prebending and reverse straining will also reduce distortion and stresses.

Postheat treatment or stress relief is another accepted method of reducing stresses and distortion. Careful consideration, however, should be given to stress-relieving the 300 series stainless steels. Temperatures giving full stress relief on other steels will only give partial relief on this group.

Maximum stress relief can only be obtained on these steels with high temperatures and rapid cooling, *e.g.*, heating to 1,500 F and rapidly quenching for a full anneal. To prevent oxidation a special furnace and heat-treating process are necessary, and to obtain maximum corrosion resistance, full annealing rather than stress relief should be used.

Figure 5 shows what happens when a cylinder without tooling is welded longitudinally—two areas (A) flatten during weld contraction. This distortion is difficult, and in some cases impossible, to correct. Thick pipe will have less flattening.

Welding in a fixture (figure 6) with copper hold-downs placed as close to the weld as possible, confines the heat, and cylinders welded in this manner will have little distortion.

Figure 7 shows six brackets welded to a thin tube. If at all possible, the holes should be drilled after welding, since weld shrinkage will move the brackets toward the cylinder center.

This movement will occur even if brackets are jig-located and held in place by pins or bolts. Thus, locators should be designed with this in mind. An unsightly ridge results on the inside of the cylinder at the weld location.

After welding, the cylinder will also be distorted and out-of-round. A mandrel is difficult to remove and can cause scoring—and will not prevent this ridging.

One effective method of minimizing the ridge and ensuring reasonable out-of-roundness is to wrap a thin copper sheet around the inside and then fill it with dry sand, as shown in figure 8.

The cylinder should be lightly tapped so it can be completely filled. Holes can be drilled in the discs for assembly on a positioner, and the positioner may be placed upright for filling. If bolts are used for fastening, they should be welded to the disc. Flanging and spot welding brackets will also produce less distortion.

The assembly in figure 9 is assumed to be 347 or 321 stainless with a 6-in. OD and ¼-in.-thick wall. If dimensions A and B, and the parallelism of the flanges are critical, allowances must be made for weld shrinkage.

Machining assembly-ends after welding and heat-treating is prefer-

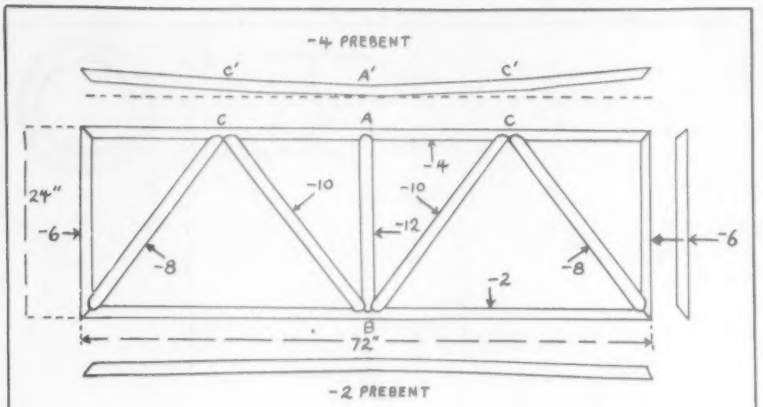


FIG. 10

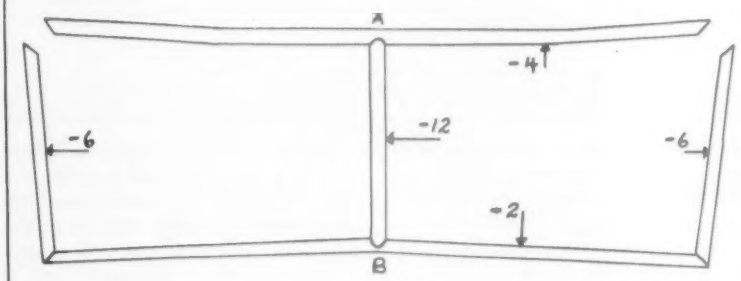


FIG. 11

able, and allowance can be made on flanges as shown. However, here it is assumed that flanges and elbows are finished machined.

Section C is left long and is machined for welding on one end only. Section D will be cut to length, and the inside diameters of mating parts should be within close limits. (Unequal diameters can cause misalignment and defective welds.)

The first step is to weld section C to the flanges using a positioner. A collapsible backup-ring with a copper strip fastened to the outside is excellent. Before welding these sections, scribe four more or less equally spaced lines across the weld; and position two light center punch marks a known distance apart.

After the weld is made and completely cooled, check these marks to determine weld shrinkage. By using four locations, any variation can be noted. Face and bevel, or groove, the tube ends to the required length plus the known shrinkage.

Section D can also be machined for welding by adding twice the shrinkage to the known length. Or the elbows can be tacked to the assemblies already welded; assembled in a fixture to obtain the section D length; then adding twice the shrinkage.

Note that weld shrinkage direction in sections C will be along the lines JJ and KK, while that of section D is in a 90 deg direction to that of section C.

Therefore, on final assembly, flange locators should be placed accordingly and allowed to move as shrinkage takes place. All components are now assembled in the fixture and tacked (section D solidly to hold the other sections in line). The welds at E and F are then made, and finally those at G and H.

Figure 10 is a frame made from seamless tubing, 1¼ OD by 1/16-in.-thick wall. If the parts are all cut to length, tacked as a unit and welded, there will be distortion and dimensions will be incorrect.

Prebending the tubes (—2 and —4) will allow contraction in welding to pull them to correct location. Note that —4 is bent in three places, A' and C', and that a certain amount of flat is left at C' due to weld width on —8 and —10.

At B, —2 is prebent, and since the diagonal —8 will pull in —6, the miter is cut at 48, not 45 deg. This is also true of the mating end of —6. The amount each tube should be bent is largely a matter of experience. Simulated sample welds will help determine the amounts.

For accurate overall measurements, —6 and —12 should be long. For example, if tolerance is ±1/32, top tolerance should be used, or slightly above. This also applies to —2 and —4. Diagonals —8 and —10 should be at least 1/32 above top tolerance.

Figure 11 is a partial assembly; —12 is welded at A and B, and —6 ends are welded out-of-square. The weld at A has pulled —4 to where G is in position for locating —10. Next —10 is welded at B and C, then —8 is located, welded and finally mitered at the top.

For some assemblies, tooling should be provided with cam operated, adjustable tube locators to position prebent parts and allow movement to their correct locations.

Pipeline News

The Federal Power Commission has authorized Chicago District Pipeline Co., Joliet, Ill., to build natural gas facilities costing $12,900,000 to transport gas received from Midwestern Gas Transmission Co., Houston. Chicago District will construct 50.1 miles of 36-in. main line, and 2.3 miles of 30-in. lateral line. Midwestern can also build 350 miles of 30-in. line from Portland, Tenn., to Joliet in order to deliver a possible peak day total of 360,000,000 cu ft.

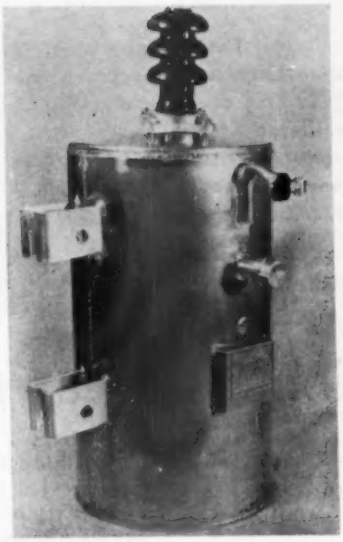
Cities Service Gas Co., Oklahoma City, has been authorized by FPC to construct 65.9 miles of pipeline of varying sizes, and to install a 2,140 hp compressor. Total cost for construction will be $8,217,000.

FPC has approved $865,000 construction by The Ohio Fuel Gas Co., Columbus. This will include 6.4 miles of 24-in. pipe in Licking County, Ohio, and addition of 1,500 hp to its Pavonia compressor station.

FPC has authorized Trunkline Gas Co., Houston, to construct natural gas facilities for a total of $1,000,000, with the cost of any single project not to exceed $250,000.

New York State Natural Gas Corp., Pittsburgh, has been granted FPC permission to construct pipeline facilities to cost $4,470,140. This will include 40 miles of 20-in. pipe and 1.6 miles of 6-in. line, all in Pennsylvania. Each of five existing engines at Preston compressor station will be increased 350 hp.

AT far right, weldor Tig welds fittings on aluminum transformer case. At right, completed 100 KVA tank. Fittings and cooling fins were welded with 5356 aluminum welding rod. Tanks are built in 10 to 100 KVA sizes. Below, cover is welded on tank, sealing the unit from moisture.



Tig welding, aluminum used to manufacture durable and economical transformer cases

THE ATMOSPHERE of the West Coast may be good for the citrus fruits but it causes steel transformer cases to rust out in 3 to 5 years. When this happens, oil leaks, causing friction which heats up the transformer and burns it out.

Economy Transformer Co., Centralia, Wash., thought it could increase case life by making them of non-corrosive aluminum alloy. The basic materials would cost more, the firm realized, but it decided the other advantages—the light weight, better dissipation of heat, no need for painting—would keep other costs down.

The tank cylinders were rolled from 5356 corrosion resistant sheet aluminum ⅛-in. thick. Top and bottom were cast of 4043 aluminum. Trouble came in trying to weld the sheet to the thick casting. Welds were porous, cracked easily, and were taking too much time to make.

After examination, it was decided two procedures would improve weld quality: meticulous care must be taken in sanding and cleaning the aluminum before welding, and Tig welding should be used with 5356 rod.

To produce a tank, aluminum sheet is rolled, sanded free of oxide, and tack welded with a water-cooled hand torch powered by a 300-amp a-c welder. The cylinder is then fitted over the bottom casting and tack welded to it. The longitudinal seam of the sheet aluminum is then Tig welded, using a ⅛-in. diameter, 36-in. long filler wire supplied by All-State Welding Alloys Co.

The transverse seam around the casting is welded, forming an open tank. Fittings and cooling fins are then welded to the tank sides using the same alloy.

Next, the coil is inserted into the tank and the top sealed with another transverse weld. Weather heads to protect electrical connections are then welded on, again with the hand torch, using a ⅛-in. 2% thoriated tungsten non-consumable electrode. An argon gas flow of 14 liters per minute is used as a shield.

A high-frequency a-c current stabilizes the arc and causes ionization. The high frequency also causes a cleaning action on the parent metal. Amperage is adjusted with a foot-controlled rheostat. This arc control determines depth of penetration, width and height of bead.

With the production problem licked, cost comparisons were made between steel and aluminum units.

When using mild steel, the cases weighed 150 lb, and used 7 lb of rods at a cost of $13.65 per tank. The nine hours of labor cost $36, while cleaning, painting, bolts and gaskets cost another $25. Total cost was $74.65.

An aluminum tank weighs 55 lb, uses 1½ lb of electrodes at $2.13. It takes four hours of labor to fabricate, at a cost of $16. Since welding is used, no bolts or gaskets are needed, and the aluminum requires no painting. Total cost of an aluminum case is $18.13—a savings of $56.52.

Last October Welding Engineer reported on the construction of the first geodesic dome to be put to an industrial use in the United States. It was built by Union Tank Car Co. to house railcar maintenance shops. This same company is now building another hemisphere, this one at Wood River, Illinois, where it has maintained a plant since 1913. Herein is described how welding and thin sheet steel are used as a . . .

Modern geodesic dome replaces an old-fashioned railcar repair plant

UNION TANK CAR CO., owner of the world's largest circular industrial building, situated at Baton Rouge, La., is building a comparable geodesic dome at Wood River, Ill., 25 miles north of St. Louis.

The Baton Rouge dome reportedly cost less than $1,000,000 to build—but the new dome is expected to cost even less. Graver Tank & Mfg. Co., East Chicago, Ind., division of Union Tank, had its engineers develop some time and cost-saving methods designed to make the second dome even more economical to construct than the first.

The Wood River structure, like the one at Baton Rouge, will house regional railroad tank car repair and maintenance facilities. The building, when completed, will be 120 ft high at the center, 380 ft in diameter, and because of the geodesic design eliminating internal supports, enclose an unobstructed area of 110,000 sq ft.

Availability of 84-in. wide, 11-gage hot rolled sheet steel, supplied by Jones & Laughlin Steel Corp., Pittsburgh, has reduced the amount of welding needed at Wood River by approximately three-fourths. Sheets only 43½ in. wide were used at Baton Rouge.

Prefabricated panels for the latest dome are umbrella-like hexagons 2 ft high and 12 to 17 ft across the base. To form the hemispherical building, 804 panels are being welded together.

Where panels are being butt welded, an E6012 electrode, 5/32-in. in diameter, is used. To weld compression members to the panels, an E7017 electrode, 3/16-in. in diameter is used. All welds are made in one pass, using manual metal arc welding. Single operator motor generator sets of 300 amp capacity provide weldors with d-c power.

Prior to welding, edges are sheared and square butted. No post welding treatment is needed.

The panels were fabricated in Graver's East Chicago plant, and are being assembled by its crews in the field. Steel was supplied for panel fabrication in 14 different lengths. This enabled workmen to make the small pyramids in various sizes with a minimum of waste.

An example of the waste-minimizing procedures can be followed in Fig. 1. One-half of a panel was cut from the center (A) of a 361-in. long sheet. 7-ft wide, and

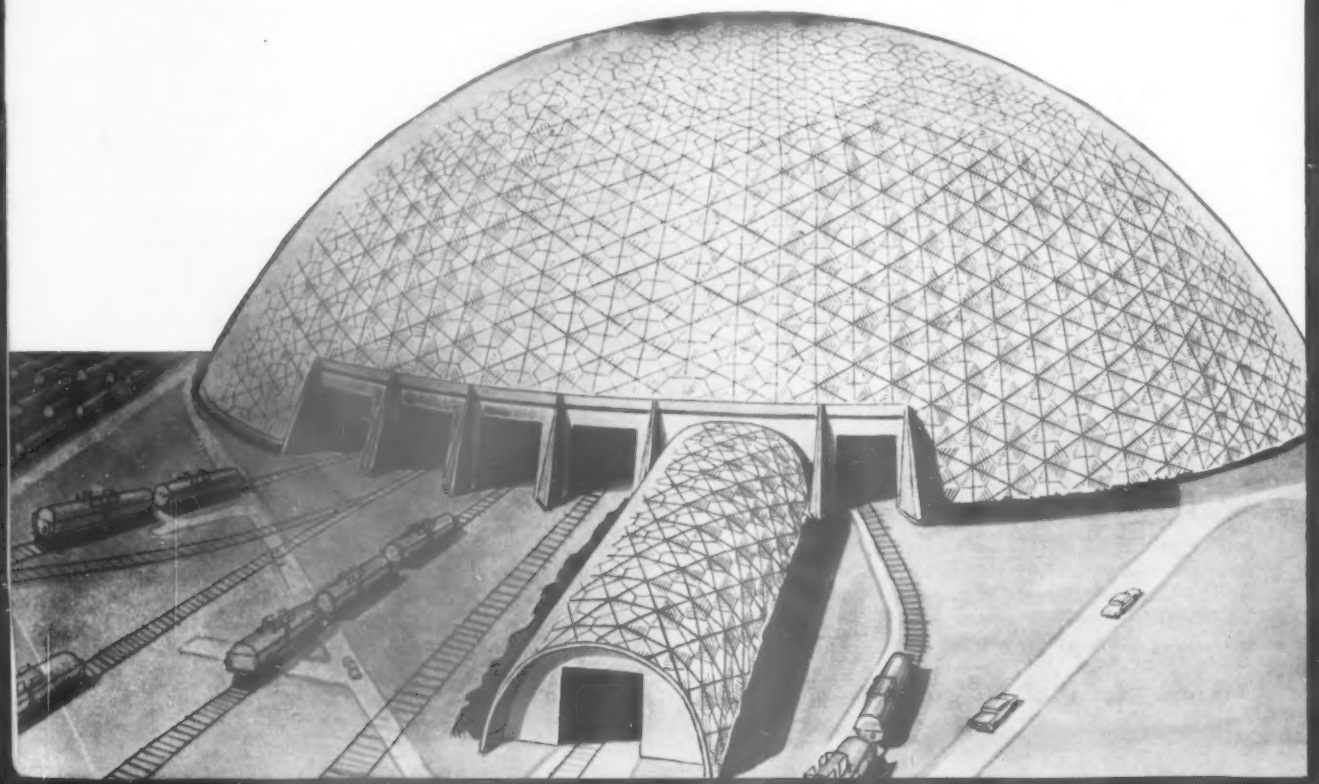


Fig. 1.

⅛-in. thick. The cuts were made with the required angles for three sides of the base of the pyramid. The other half of the panel was made by welding together the square ends (B & C) of the sheared panel. The two halves were then trimmed to design shapes, formed into a pyramid, and manually welded into a complete panel.

One time-saving method used at Wood River, a reversal of that followed at Baton Rouge, is the erection procedure. Using a specially designed spherical scaffold 30-ft high at the top center, workmen first welded an initial 200-ft diameter center section. Jacks and a huge air-inflated expanding pneumatic bag were used to raise the strut-reinforced dome to its maximum center height of 120 ft.

After each step up, a ring of panels is welded to the dome's perimeter. In this way weldors are allowed to work at or near ground level during most of the assembly.

Until completion, the dome is prevented from slipping in any direction by a system of adjustable guy lines. These are attached at 120 points around the dome and anchored to 10 buried concrete deadmen spaced 36 deg apart on a 306-ft radius.

The most obvious difference between the two domes is the external supporting truss structures. A triangular pattern is used on the Wood River facility, while a hexagonal system was installed at Baton Rouge.

The southern dome's supporting structure is a complex one consisting of 4-in. pipe struts forming hexagons that outline each pyramid and hold the dome by means of smaller steel bars connected to the vertex and corners of each panel. In effect, the dome hangs from the small steel bars.

Wood River's structure is simplified, eliminating the small bars. Six-in. schedule 10 steel pipe, 12 to 17 ft long, is attached to the vertices of all adjoining pyramids, interconnecting them. Full-scale sandbag loading tests proved the strength of this simple construction. The dome was designed to withstand hurricane winds exceeding 100 mph and snow loads up to 30 lb per sq ft.

Foundations for the structure were designed to support only a load equivalent to a 15-ft high concrete wall, 1-ft thick. The geodesic design, patterned after the architectural principle of the egg, uses thin sheet steel and struts so efficiently that for every cu ft of space enclosed—in this case approximately 15,000,000—there are only 2 oz of structural weight.

The simple efficiency of such structures is further emphasized by the fact that the bill of materials for the Wood River dome lists only seven items.

HALF of each hexagonal pyramid panel for geodesic dome at Wood River, Ill., was made by automatically welding two ends of a steel sheet, as weldor is doing here. Amount of this welding was reduced to one-third of that needed at Baton Rouge because Jones & Laughlin was able to supply Graver with more than 400 tons of 11-gage, 84-in.-wide hot rolled sheet steel for panels. Sheet 48½ in. wide was used at Baton Rouge, and required six welds per panel.

WELDOR is joining two sheared and formed pieces of steel, positioned on jig, to complete panel. After panels are completed, they are grit blasted on both sides and coated with red-lead paint. Graver prefabricated 900 panels, 804 of which were used for dome. Round plate shown over vertex of closest panel is used to position six struts for welding. This eliminates overlapping strut ends. Sheared and formed panels ready for manual welding are shown in rear.

TESTS of strut layout were made on 50-ft by 60-ft full scale dome section of hexagonal pyramids. SR-4 resistance wire strain gages on plates, gussets and 6-in. pipe struts showed effects of sandbag loads up to 85,000 lb, variously distributed. Dome was designed for a snow load of 30 lb per sq ft and winds exceeding 100 mph.

WELDORS at work in Chicago classroom used by Peoples' Gas for its special course. It was designed to produce qualified engineers, supervisory personnel, foremen and pipe welders to meet increasing trend toward welding gas distribution piping.

Chicago utility conducts own pipe welding course

A TAILOR-MADE instruction course was recently conducted for weldors of Peoples' Gas Light and Coke Co., Chicago. The course was designed to increase the skills of company weldors in the specialized field of pipe welding using both arc and oxyacetylene techniques.

John E. Damm and Peter Shunt, supervisory engineers in the company's engineering and test departments, respectively, were in charge of the course. H. A. Sosnin, of Tube Turns Div. of Chemetron Corp., Louisville, Ky., helped develop and conduct the program, aimed specifically at gas distribution piping problems.

Two concentrated, week-long programs covered welding techniques, fundamentals and practical work on pipe from 4 to 10 in. in diameter. Special emphasis was placed on overhead welding.

FLAME-cutting is important to field installation of welded steel gas distribution pipe. Gay Rignor causes swirl of sparks in classroom as he practices cutting pipe to length.

ARC welding in overhead position is practiced by Martin Walsh, Peoples' Gas foreman, as H. A. Sosnin, developer of course looks on.

"COMEBACK" for oxyacetylene welding is seen in growing trend toward welded pipe for gas distribution. During course, Sosnin, left, stressed economy and efficiency advantages of oxyacetylene method for welding small pipe. Eugene O'Neill, right, perfects his gas welding technique.

TESTING strength of small diameter pipe was important part of course.

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This is a further explanation of residual stresses caused when welding. It is in answer to a letter which appeared in the July Welding Engineer *as an aftermath to the original article on residual stresses which appeared in the June issue.*

by **R. E. Holt***

Importance of considering welding stresses reviewed

RESIDUAL STRESSES EXIST in all welds and are important when considering design load. Here, we explain what caused permanent deformation in a wide-flange beam when loaded with 30% of its design capacity.

First, we must keep in mind three factors: the residual stress pattern resulting from welding transverse to the beam length can produce conditions that cause deformation; the proper choice of welding electrode, fit-up, weld size and freedom from internal weld defects are assumed; the beam, as purchased, has a residual stress pattern.

Let us examine the results of non-uniform heating caused when welding a tee-joint on the now deformed beam.

The web is welded first going from A to B (Fig. 1). The stress pattern resulting is shown in sketch A (Fig. 2). Low carbon steel flows plastically at about 30,000 psi and does not strain harden (increase in yield strength) until some 2% elongation takes place. Thus, the web will have a nearly uniform tensile stress of 30,000 psi for its entire depth.

This stress is due to the upsetting of the heated metal while confined from free expansion by the two flanges, each having cross-sectional areas equal to the web.

A volume so confined need only be heated to 650 F to produce this residual tension. During welding this temperature will be exceeded for some distance to each side of the weld. A varying stress level will be present in the flange due to rolling stresses still active in these unheated portions of the section.

Next, the web of the channel is welded to the flange of the beam by welding from A to C and B to D. A stress pattern resulting from this heating is shown by the solid line in sketch B (Fig. 2).

The flanges are under compression before welding and will upset at lower temperatures than if they were stress free before welding. This compensates for their rather large mass. The edges of the flanges are at yield point tension for about 1¼ in. from each edge. The web is at yield point compression for over 40% of its depth.

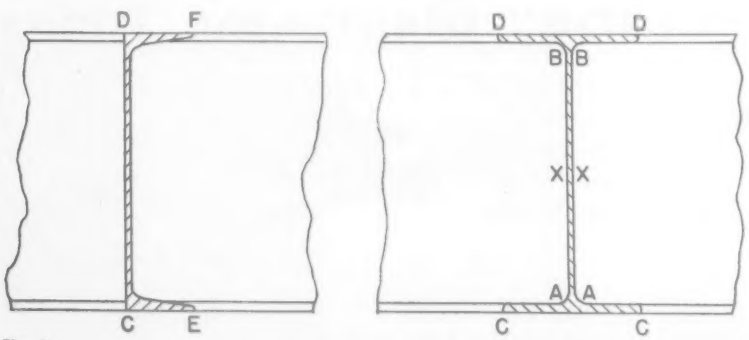


Fig. 1

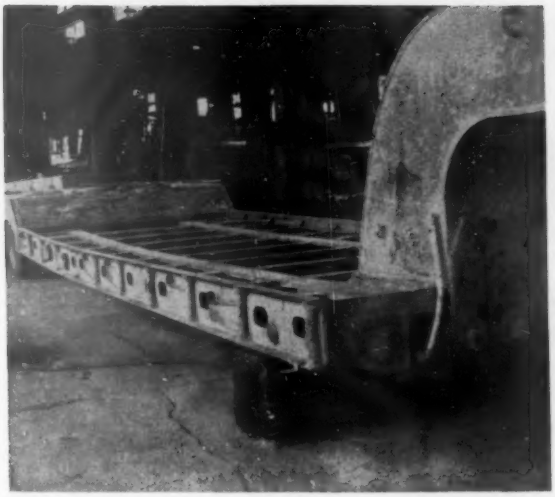
This pattern can vary with the amount of delay between welding the web and the flange connections, but the least severe pattern still will have yield point tension on the flange edges. Such a stress distribution is due to the edges of the flanges cooling last and the need for the web to come under considerable compression to balance the heavy sections under tension.

A stress pattern imposed only due to a bending moment sufficient to produce 5,000 psi in the extreme fibers is shown in sketch B as a dotted line. This pattern must be added to the solid line distribution. The sum is shown in sketch C.

When a condition of low strain values exists a material cannot be loaded beyond its yield point. For this reason, the 30,000 psi (yield point) values in sketch B will not be changed by the addition of a 5,000 psi load. Instead, these areas will experience plastic flow, thus requiring adjacent areas to assume an increased amount of stress over and above a straight addition to balance the imposed moment.

The flange portion in C is only

*Assistant professor of mechanical engineering, University of Washington.



ACTUAL sag in member will be function of length of beam, load distribution (uniform or concentrated), and number of cross members so welded to beam. Truck at left is an example of such a failure.

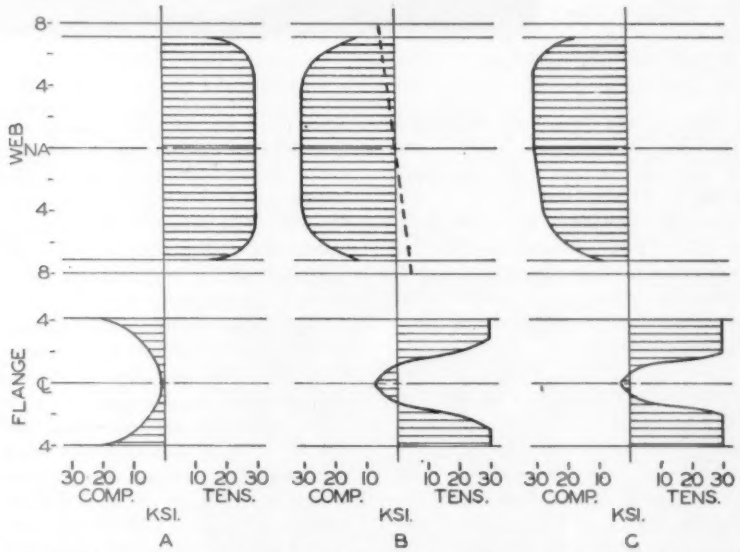
for the tension flange as the compression flange will not flow plastically and is not shown. The pattern shown in C will indicate plastic flow in the flange edges of the tension flange in 2 in. of width on each edge.

This will amount to a permanent angle of rotation of 0 deg 07′ (¼-in. in 10 ft) when the load is removed. Some plastic flow will be experienced in the web for 6 in. from the neutral axis toward the compression flange.

The actual sag in the member will be a function of the length of the beam, load distribution (uniform and concentrated), and the number of cross members so welded to the beam.

A proper weld sequence can leave a residual stress pattern after welding that will not cause any plastic flow to take place when the total design load is applied.

Weld sequence is a design function and not one to be left entirely to the shop. This matter is of extreme importance if stress relief cannot be economically applied and will give a decided competitive advantage in any event.



THESE sketches are graphs of longitudinal stresses in an ASTM A7 steel 16WF 78 beam at various times during welding (A & B) and when loaded to produce 5,000 psi stress in extreme fibers. These stresses are present for at least 2-in. on each side of the weld joint and then their magnitude will diminish quite rapidly with distance from the weld. It must be remembered that it is heating due to welding that induces these stresses and no weld metal is being subjected to these stresses. The same pattern could be produced by non-consumable arc welding without depositing a weld at all if the same sequence and heat input were used.

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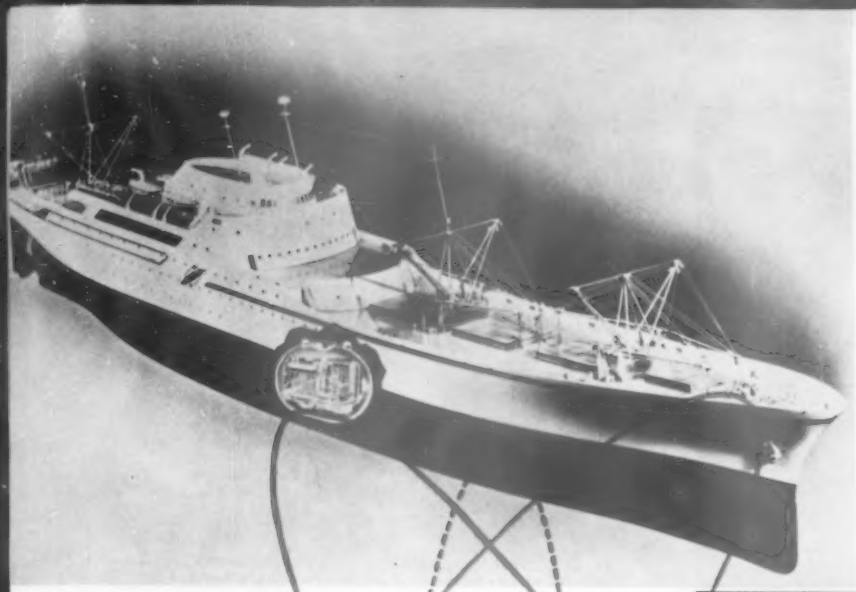
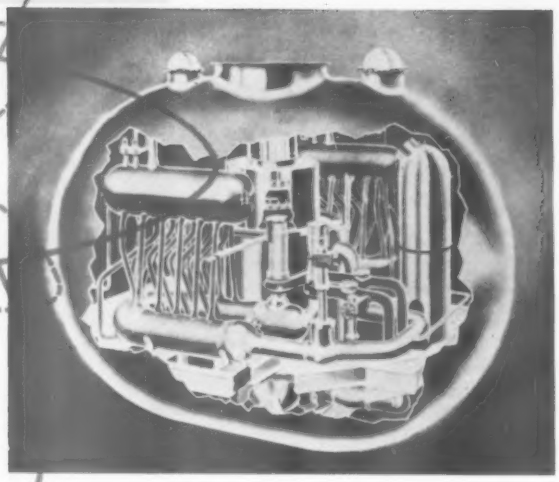


SLEEK look of the nuclear merchantman is due to the absence of smoke stacks. The reactor (seen in the hull and below) is capable of powering the ship 300,000 nautical miles and 3.5 years without refueling.

N. S. Savannah

Welding helps launch first nuclear-powered merchant ship



THE WORLD'S FIRST NUCLEAR-powered merchant ship slipped down greased ways on July 21, opening the door to a new era in shipping.

Although this is merchant shipping's first introduction to nuclear propulsion, welding is an old hand at the business and lent its help in construction of both the ship's hull and the reactor vessel.

Authorized by Congress in 1956, *N. S. Savannah* is named after another "door-opening" merchantman, the *Savannah* of 1819, first vessel to use steam on a transatlantic crossing from Savannah, Ga. to Liverpool, England.

The small (320 tons) ship made its successful voyage in 29 days and 11 hours, even though it could carry only enough coal and wood to permit about 89 steaming hours spread over at least seven days.

Built by the New York Shipbuilding Corp., Camden, N. J., at a cost of $20,908,774 the new *Savannah* displaces 22,000 tons; has an overall length of 595.5 ft; a molded beam of 78 ft. With accommodations for 60 passengers, the ship can carry a crew of about 110 and about 10,000 tons of dry cargo at a cruising speed of 21 knots.

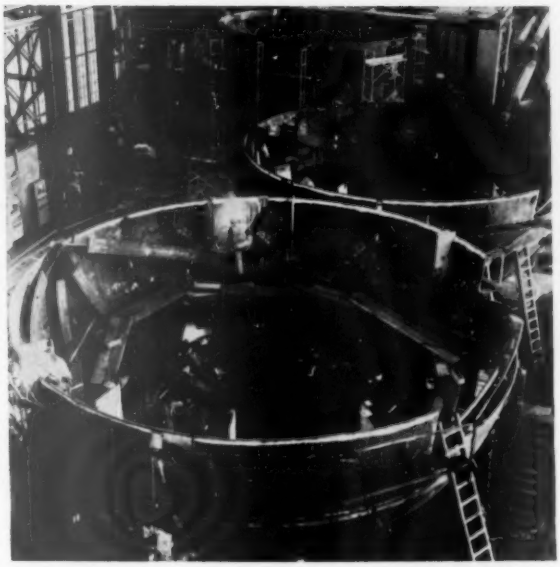
And with its nuclear reactor, *Savannah* can travel an estimated 300,000 nautical miles in 3.5 years without refueling. The reactor, built by Babcock & Wilcox, New York City, at a fixed price of $9,872,000, is the same as those in *USS Nautilus*, *USS Skate* and the Shippingport Atomic Power Station in Pennsylvania.

The reactor containment vessel is 35 ft in diameter and 50.5 ft overall in length, and has a dual purpose: *(1)* to house the ship's entire reactor plant and primary cooling system, and to contain all water and steam released should a mechanical failure occur in the pressurized water loops; *(2)* to support the lead and polyethylene shielding covering the upper half of the containment vessel under a 30 deg roll.

(The containment vessel is similar to the one described in WELDING ENGINEER, *Welding—key . . . to nuclear reactors*, August, p. 27.)

The vessel's center cylindrical section is 35 ft in diameter and 16 ft long, made of carbon steel varying from 2⅜ to 3¾-in. thick. Two hemispherical ends, 1.24-in.-thick, are welded to this portion, as well as a cupola 14 ft, 6 in. OD, 16 ft high on top of the cylinder section. All steel is SA-212, Grade B.

The two hemispherical heads and the center section were fabri-



CONTAINMENT vessel consists of center cylindrical section (background) and two hemispherical ends (foreground) welded with low-hydrogen E-7016 electrodes.

cated separately with E-7016 low-hydrogen electrodes manufactured by the Metal & Thermit Corp., Rahway, N. J.

All welds in each section were preheated and the roots inspected with magnetic particle. After completion of welding, all butts and seams were 100% radiographed.

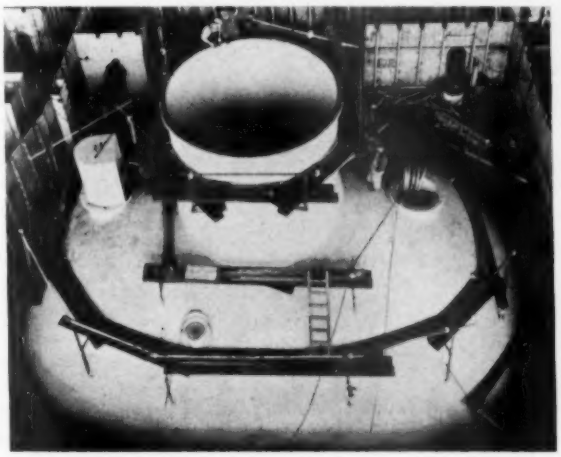
Each section was then stress-relieved and assembled in place on the ship. Following this assembly, the entire containment vessel was hydrostatically tested at 173 psi, keeping the minimum shell temperature at approximately 100 F to eliminate any possibility of brittle fracture.

Because of possible damage to the reactor in case of collision or grounding—and the resulting danger to personnel—the inner-bottom, the area below the reactor space, is "egg-crated" with transverse floors at every frame.

In addition to this strengthening, two heavy longitudinal collison bulkheads adjoining the reactor space were included. Outboard of these bulkheads are heavier-than-normal plating continuously welded to the beams at the B, C, and D decks. Inboard of these bulkheads are collision mats of alternate layers of 1-in.-thick steel and 3-in.-thick redwood.

Should a broadside collision occur opposite the reactor space, the ramming ship would have to penetrate 17 ft of stiffened ship structure, the heavy collision bulkheads, 2 ft of collision mat, 1.5 ft of reinforced concrete shielding, and the containment vessel before damaging the reactor plant.

Just as the old *Savannah* ushered in the Steam Age in ocean travel, the *Nuclear Ship Savannah* is ushering in the Atomic Age for merchant shipping—with welding's help.



COMPLETED vessel is 35 ft in diameter; stands 50.5 ft high; houses the ship's entire reactor plant and primary cooling system. It is designed to contain all water and steam released in any reactor failure.

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AFTER shearing and two bending operations, steel sheets are butted, then welded on one side only. Shear is in left background.

Despite the inroads automation has made, there are still a great many concerns—small and large alike—that use only manual welding to fabricate their products. Here is such a firm.

Hand welding still most economical in many cases

BENDING brake (at left) is used to form double sheet, which is pictured upside down.

WELDING ENGINEER constantly depicts the importance of welding in our daily lives. But welding frequently (if not always) accompanies even beyond this vale of tears . . . no flippancy intended.

In many parts of the United States, and especially in smaller communities, burial vaults are steel rather than concrete. Naturally, they are welded.

In Upper Sandusky, Ohio, Wyandot Metal Products Co. produces approximately 17 such vaults daily. W. C. A. Bickham, Sr., who took over the firm in 1936 (it was founded in 1923) claims Wyandot is the largest exclusive manufacturer of metal burial vaults in the country. His son, Jim, now heads the company.

Aside from their basic materials, metal vaults differ from their concrete counterparts in one important way. The former has a base plate upon which the casket is laid, and a metal dome is lowered over it.

Wyandot vaults are made from 12-gage hot-rolled mild steel (10-gage is used occasionally). All welding operations are performed with one type of electrode—E6012, which can be used for all-position welding with a-c or d-c straight polarity. The firm uses d-c primarily. It owns three

TACK welds are made to join head panel to dome.

motor-generator sets and one a-c transformer.

The production sequences begins by shearing received plate to specified dimensions. Plate edges are butted tightly, leaving no gap. After tack welding, a one-pass weld is laid in the flat down the length of the joint.

Amperage used is within the recommended range of 120-200 for the 5/32-in. diameter electrode, and voltage is 26 to 28.

Welds need be only watertight, so no strength tests are made, but deposited weld metal, with a tensile strength of about 75,000 psi, results in a sufficiently strong joint.

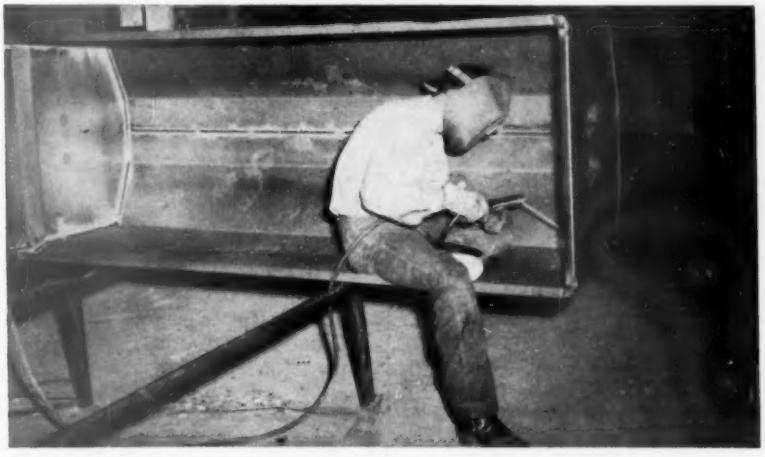
The welded double sheet is removed to the bending brake where it is formed to make a rectangular dome. After bending (the number of brakes depend upon the model), head panels are joined to either end. After tacking, one pass on either side of the joint on both heads is laid in the vertical (both up and down) position. Each vault contains about 40 linear feet of welds.

The welds are then ground flush, and the dome section of the vault is ready for painting.

Wyandot uses approximately 600 lb of electrodes per month. It employs four welders, half of its total work force.

The welded metal vaults they produce are used in every state in the Union, according to the senior Bickham. However, most of them are sold (through jobbers) in the South.

A product we don't often talk about, burial vaults nevertheless are another example of the far-reaching influence of welding.



CONTINUOUS welds are made on either side, completing head-to-dome joint.

a completely new d-c welder

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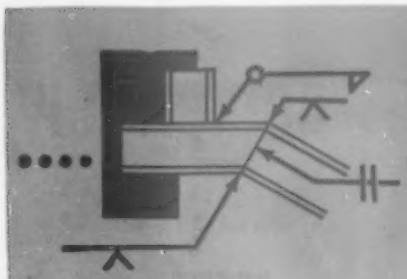


the welding clinic

Here you may find the solution to your welding problems, whether they concern design, production, construction or maintenance welding. Submit your questions for answering on this page.

How to keep working air pure

Question:

We run a shop in which many types of welding methods are used in addition to spray painting. We would like to know what type of air-purifying measures should be taken for the various operations?

Answer:

Normal welding fume exhaust ventilation from manual metal arc welding on non-alloy steels should be sufficient to remove the fumes from the operator's breathing zone, according to the National Safety Council, Chicago.

An indication of the contents of the atmosphere can be gathered from inspecting the weldor's helmet to see if fume deposits are around the filter lens. If so, present ventilating facilities are insufficient.

If heavy metal alloys, such as nickel, chrome, cadmium, magnesium or lead are being welded, the fumes should be completely collected and discharged outdoors. Fumes from cutting operations and from the welding of painted parts should be handled in the same way.

Mig (metal-inert-gas) welding requires some extra controls. Ultraviolet light emission is 5 to 30 times as strong as with arc welding. It is, therefore, necessary to take precautions to prevent skin exposure to the weldor, other employees or visitors.

Ventilation is needed to prevent high concentrations of carbon monoxide (when a CO_2 shielding gas is used) and heavy metal fumes. Nitrogen dioxide and ozone can also be hazardous.

Of special concern should be chlorinated hydrocarbon vapors in the vicinity of the inert-gas-shielded arc. The ultraviolet light will break down the chlorinated hydrocarbon vapors to phosgene. Degreasers and other chlorinated hydrocarbon sources should not be near such operations.

Dust which falls to the floor is of little consequence as long as it is swept up daily. The small amount of dust which hangs in the air and is inhaled is what can cause eventual lung damage.

Some measure of potential exposure can be made by examining the amounts of settled dust on surfaces over the operator's head and over the source of dust. If considerable amounts of dust are spotted on these overhead surfaces, there is a possibility of a dust hazard to the employees. Exhaust ventilation at the source is a reliable correctional procedure.

When spray painting in a paint booth, there are several visual inspections which can be made to see if exhaust air volumes are sufficient.

Look for paint deposited on equipment outside the booth, or on light fixtures and both walls behind the operator. If overspray is spotted, it will show if turbulence in the booth is carrying paint behind the operator or out of the openings of the paint booth.

Particular attention to turbulence is needed where paper filters are used rather than water walls for pigment removal. The paper filters will eventually clog with particulate matter and preclude exhaust flow.

The Editors will make every effort to answer all questions submitted to this department. If you have a question concerning welding or related processes—or a tip you would like to pass along to other readers—send it to *The Welding Clinic*.

Question:

We are working with a plant that manufactures metal caskets from thin gage copper sheets. Could you provide us with information on brazing with an oxy-propane flame using bronze rod as a filler metal?

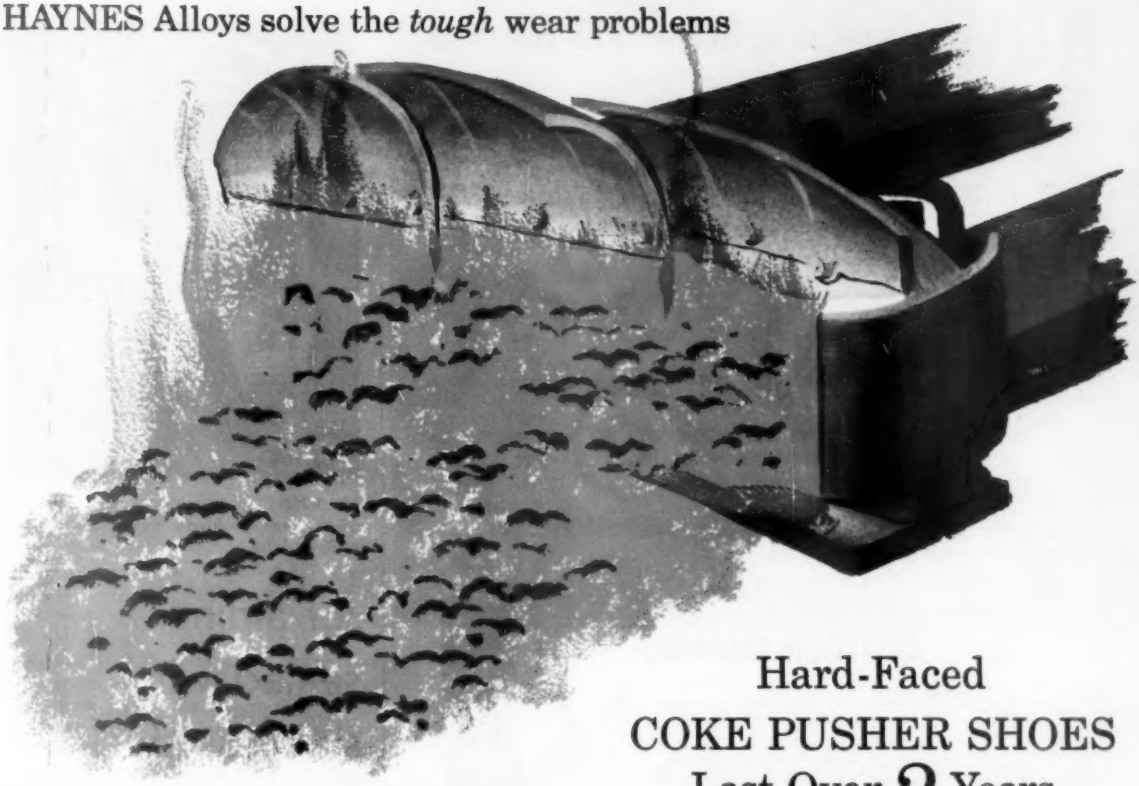
Answer:

This job should not present a problem since the oxy-propane flame is more suited to brazing applications than is the oxyacetylene flame. This is because the oxy-propane flame is softer, with much less heat input.

However, it is suggested that instead of brazing with a bronze rod, that this job be done with silver brazing. By this process you will find that the overall cost will not be much higher, if any, and that the job will go much faster. There will also be much less distortion due to the low heat input.

You should use either a phosphorous-copper alloy or an extremely low silver content brazing alloy, with the former material providing an excellent color match. The overall cost will be low, even though the filler metal might cost more than if you braze with a bronze rod.

HAYNES Alloys solve the *tough* wear problems



Hard-Faced COKE PUSHER SHOES Last Over 2 Years

These shoes, hard-faced with HAYNES STELLITE alloy No. 1, resist abrasion from the coke particles and the lining of the oven floor. The hard-faced deposit does not chip or spall under the thermal shock of returning from 1800 deg. F., in the oven, to ordinary atmospheric temperatures.

Resisting severe abrasion, heat, and thermal shock produced by riding over the coke-covered floor of 1800-deg. F. ovens—these shoes hard-faced with HAYNES STELLITE alloy No. 1 lasted over two years. Ordinary steel shoes wore out in two months.

Whatever your wear or abrasion problem, there is a HAYNES hard-facing alloy especially made to combat it. There are 18 HAYNES hard-facing alloys . . . a wide selection that assures economical protection from the most severe conditions of heat, corrosion, erosion, or wear. For the complete story write for descriptive literature or contact our nearest sales office. HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana.

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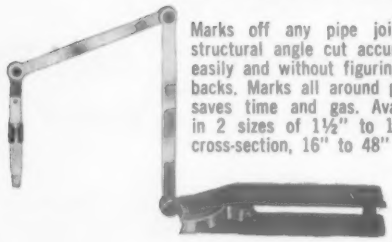
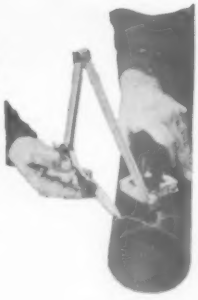


Marks off any pipe joint or structural angle cut accurately, easily and without figuring cut-backs. Marks all around pipe—saves time and gas. Available in 2 sizes of 1½" to 18" in cross-section, 16" to 48" diam.



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FOURTEEN spot welds can be seen on spring (frame). Inside frame, spot welder is at work.

Jet airliners sealed with stainless steel

AMONG THE UNSEEN but vital parts of the Boeing 707 jet airliners are stainless steel springs tightly sealing more than 100 windows to prevent leaks which could lower cabin pressure.

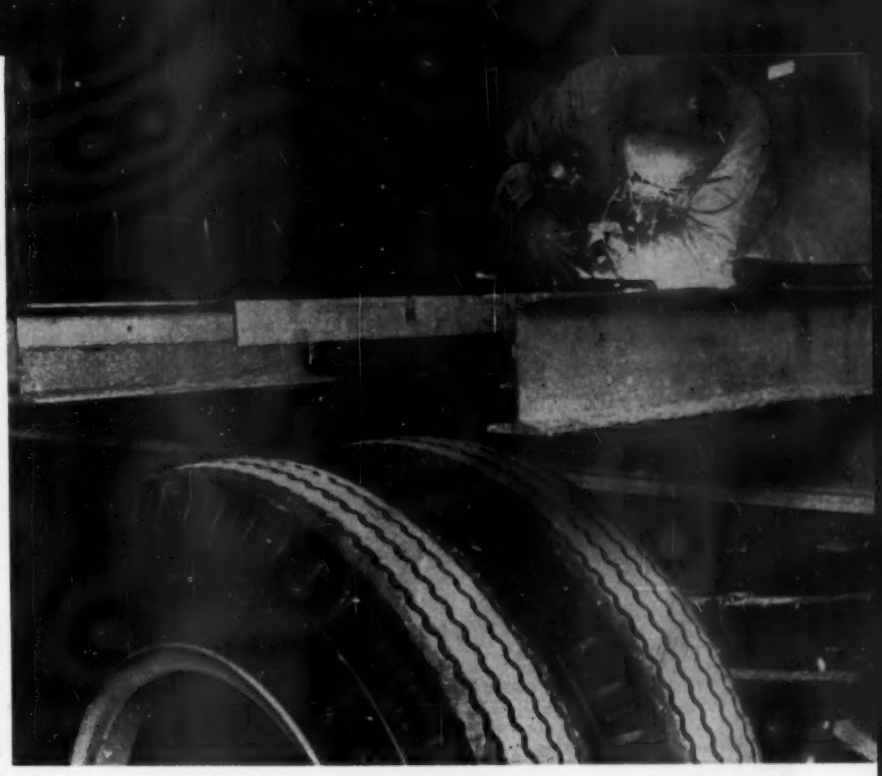
Because the springs are not easily accessible for inspection, they must be capable of standing up under compression without attention under wide and rapid changes in temperature and environment.

Type 301 stainless steel, supplied by Jones and Laughlin Steel Corp., Pittsburgh, is used. It is said to have a high strength to weight ratio and excellent corrosion resistance. Installed in a full hard condition, it has a maximum tensile strength of 185,000 psi.

The seal is compressed almost ¼-in. when installed and exerts a strong pressure on each face of the double windows. The seal is essentially a series of double elliptical springs, and weighs 7 oz.

Segments are stamped and formed from stainless strip 14½-in. wide by 0.052-in. thick. Four segments that make up a spring are assembled in a jig and spot welded. Welder is a 25 kva unit operating on 44 ov using a 0.3 second contact time with 0.400-in. contact diameter.

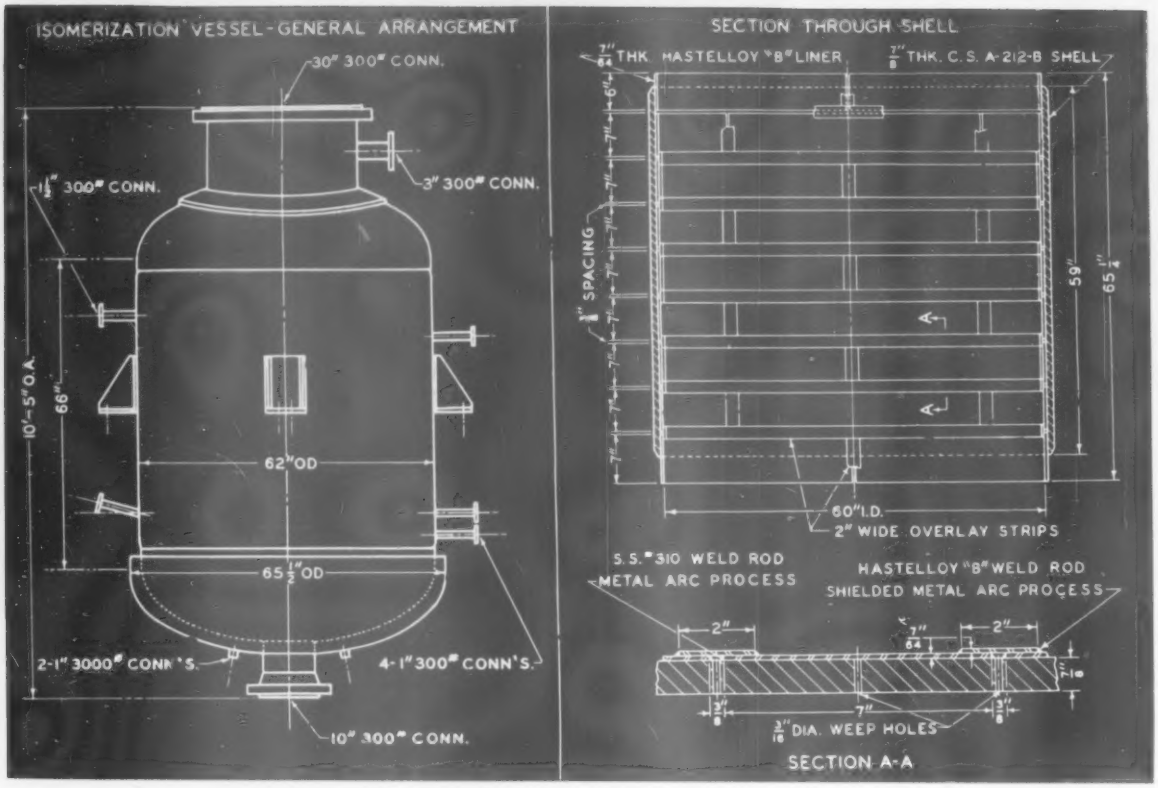
WELDOR is using an Air Reduction Co. Miget unit to join aluminum I-beams and shapes to truck chassis. Atlantic Welding Supply Co., Malvern, Pa., purchased new chassis and is constructing own cylinder body to fit firm's needs. Aluminum 4043 alloy is being used.



MILITARY specifications for a family of aluminum consoles and cabinets for radar systems required all-welded-seam construction to control radio-frequency radiation. Design requirements stated that 7250-2 aluminum alloy from 0.090 to 0.125-in. thick be used, and that for large parts, tolerances be held to 0.005-in. Mig and Tig welding methods were ruled out because distortion would be too great and equipment too slow and cumbersome. Westinghouse Electric Co. designed a new gas-shielded consumable electrode handgun for the job. It feeds wire as small as 0.020 in., keeping heat input low, thereby minimizing distortion. Handgun proved very speedy, and slashed time required for welding within confined spaces as compared to other methods.

On the job...

A Comfo twin cartridge respirator, made by Mine Safety Appliance Co., Pittsburgh, protects this welder from lead dust and fumes during repair operations at Newport News Shipbuilding & Dry Dock Co., Newport News, Va. The deadly particles, smaller than ragweed pollen, produce no immediate effect, but eventually harm the respiratory system.



SHELL section is lined with eight courses of 7-in.-wide alloy sheet. Each course contains four pieces 7-in wide by 46⅞-in. long, laid transversely one at a time.

When refining gasoline . . .

Nickel-alloy lining slashes isomerization unit costs

by **John F. De Lorenzo**
Manning & Lewis Engineering Co., Newark, N. J.

THE DEMANDS FOR HIGH octane gasolines for both civilian and defense purposes are continually increasing; as are the demands for highly corrosion-resistant process vessels to refine these fuels.

This refining or isomerization process (the combination of two or more compounds having the same molecular formula but different atomic arrangement) involves the influence of hydrochloric acid at high pressures, and temperatures up to the acid's boiling point.

A highly corrosion-resistant nickel-alloy, such as Hastelloy B, can provide this necessary protection. However, the alloy is fairly expensive and requires considerable metalworking skill to fabricate.

The most feasible means of retaining the alloy's advantages, while holding fabrication costs to a minimum, was to line the pressure vessels with the alloy.

An example of this efficient use of alloy-lining is a 13,000 lb vessel manufactured by Manning & Lewis Engineering Co. for the Atzcapotzalco refinery in Mexico.

Utilizing a procedure of applied liners, seam-sealing and overlay strips to a base of relatively inexpensive carbon steel, the cost of the vessel was held to approximately $22,000. Had the vessel been constructed of solid Hastelloy B, the total fabrication cost would have been more than twice this amount.

Another approach might have been the use of integrally clad metal. This process, still under development, is

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being successfully accomplished with shell and head material, but requires the supplier to perform fabrication and joining functions by his own manufacturing procedures. Had this method been used, it would have driven the cost of the completed vessel approximately halfway between the lined vessel and the solid-alloy vessel.

Thus, the most economical approach to the corrosion problem was construction of a carbon steel vessel completely lined with nickel alloy. Constructed under the rules of the ASME Boiler Pressure Vessel Code for service at 350 psi and 450 F, the vessel is expected to give many years of satisfactory service.

Preliminary construction steps required cutting to size and forming all carbon steel parts. The lining material (a combination of 61% nickel, 1.00% molybdenum, 1.00% silicon, and 0.05% carbon) was also cut into plates and formed whenever this could be done preceding any actual fabrication.

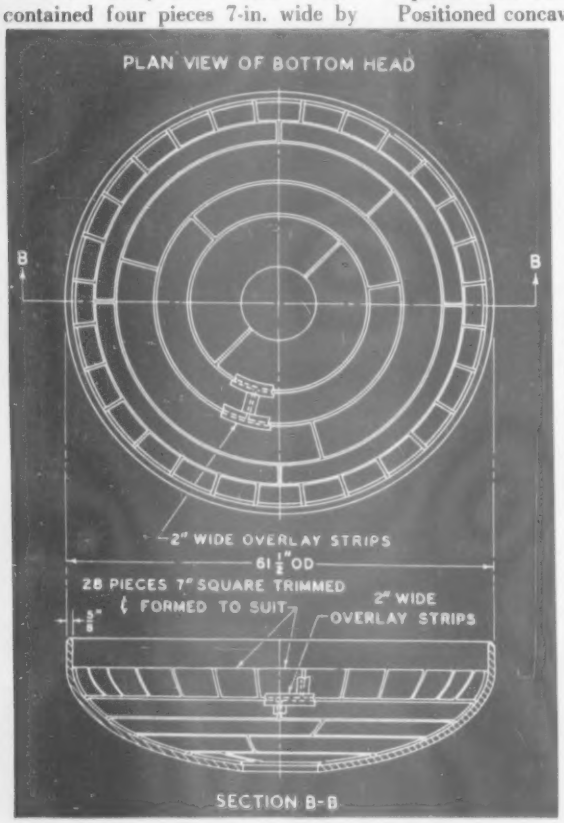
The shell section was lined with eight courses of 7/64-in.-thick by 7-in.-wide alloy-sheet. Each course contained four pieces 7-in. wide by 46⅞-in. long, laid transversely one at a time.

Prior to welding each liner piece, the shell area to be covered was sandblasted. A hydraulic jack and a hard wood form kept the strips tight against the shell, providing greater welding ease, as well as dissipating the welding heat. No preheating was done because the alloy is hot-short at elevated temperatures.

Joining the carbon steel to the alloy liner was done by the manual metal-arc process in down-hand position using coated stainless steel 310 electrodes. Normal current for the 3/32-in.-diameter electrodes was 90 amp at 25 volts.

To minimize the heat effect on the alloy, the electrode was directed almost entirely on the steel with the arc edge making contact with the liner. A single bead was used and laid at the most constant speed possible for manual welding. To avoid locked-in stresses, one short and one long liner edge were welded and allowed to cool prior to welding the other two edges.

The procedure for lining the elliptical head was more complicated. Positioned concave side up, the head was surmounted by a pipe tripod, with the tripod legs clamped to the straight flange. The apex served as the pivot point for the hydraulic jack that exerted pressure on the hard wood forms used to position and form the various liner pieces. Welding technique is similar to that used on the shell.



LINING the elliptical head was more difficult, since a pipe tripod with a hydraulic jack and hard wood forms was needed to position and form the various liner pieces. Welding technique was similar.

The spaces between adjacent liner sections were covered by 2-in.-wide strips of 14-gage alloy. These overlay strips were held in position in the same manner as the liner pieces, and were Mig welded with 3/32-in.-diameter bare wire as filler metal. The channels under the overlay strips were continuous throughout the vessel to permit testing the overlays for leakage.

Testing of the lining was done by introducing pressure behind the overlay strips. Weep holes 3/16 in. in diameter were drilled behind all pieces of overlay stripping and a similar hole was drilled behind each piece of liner plate.

Pipe couplings were then welded over each weep hole and air under 15 psi pressure was introduced through an overlay-strip weep hole at one end of the vessel. All other weep holes under the overlay strips were checked for air flow and then plugged. This procedure assured that air would flow through the space under all overlay strips.

With all weep holes plugged, inside seams were checked for leakage by preliminary soap and water tests, followed by highly sensitive tests using freon and halogen leak detectors. These showed all seams free of leakage. The plugs were then removed and an internal halogen test was performed with all external seams and weep holes being probed.

After removing the couplings, weep holes in the bottom head were plug welded. The bottom head jacket was then installed and the entire unit subjected to a final hydrostatic testing at 525 psi in the shell and 115 psi in the jacket.

Checked out and meeting all standards, the vessel was finally trucked to New York harbor and shipped to Mexico, where on arrival it became an integral part of the isomerization unit of Petroleos Mexicanos refinery.

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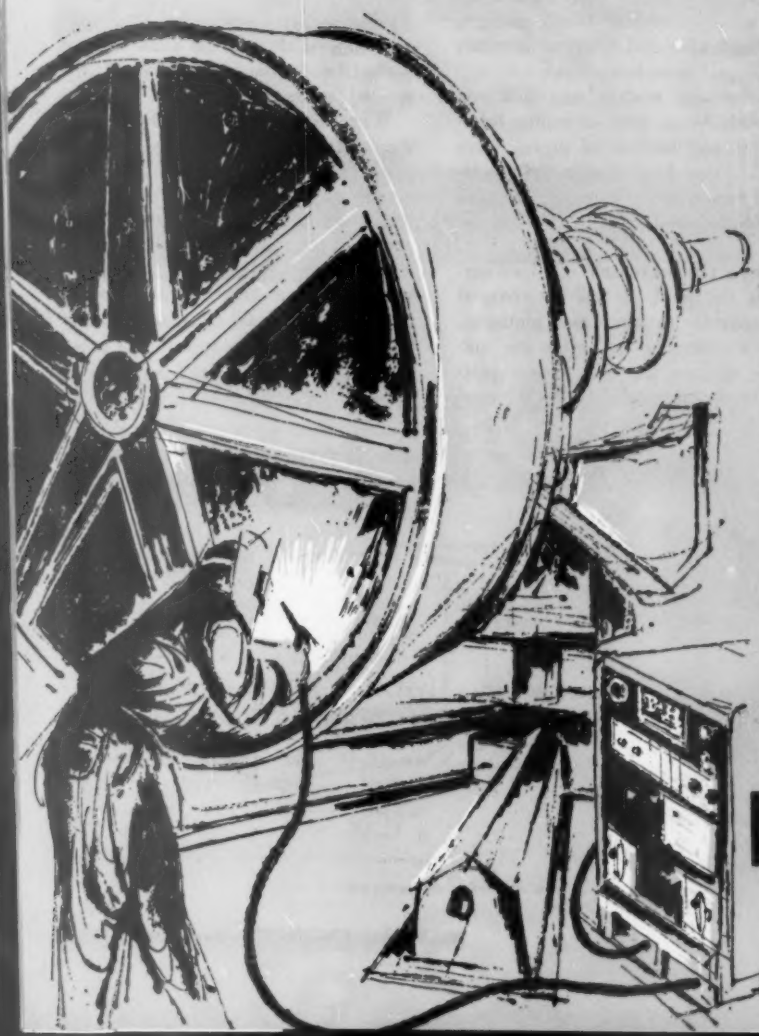

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ROOFTOP view of piping shows interruption in center section of system around swimming pool's periphery. In winter, pool will be covered, and additional piping mechanically installed to complete rink's network.

Plush motel, plush pool, plush rink

by **F. T. Tancula**

THIS IS A STORY about an ice rink—a luxurious one in a setting even more luxurious.

It is the property of the sumptuous Villa Moderne motel, just a few miles north of WELDING ENGINEER's Morton Grove offices. Naturally, welding plays an important role in the story.

The network of piping which will carry brine for the ice-skating arena consists of welded schedule 40 pipe, 1 in. in diameter (with 4-in. headers). The system is elliptical, corresponding to the shape of the swimming pool it surrounds. At maximum dimensions, the rink will be 135-ft long by 105-ft wide.

Foreman Harry Mackie of Burge Ice Machine Co., Chicago, said his firm has built larger rinks, but that this one was of unusual shape.

There are approximately 35,000 linear feet of the brine-carrying pipe, with about 1,000 welded joints. Welds joining sections of the headers, as well as the 6-in. diameter underground mains, were made with E6010 electrodes on d-c reverse polarity. Power source was a 250-amp gasoline-engine driven welding machine.

Joints in the 1-in. pipe were made with an oxyacetylene torch, using a mild-steel filler rod. Oxygen pressure was 20 psi; acetylene, 7 psi.

The piping system was laid out with only $\frac{1}{8}$-in. plus or minus tolerance. If any section of piping were outside these level limits, soft spots would result on the ice, once the rink was flooded and frozen.

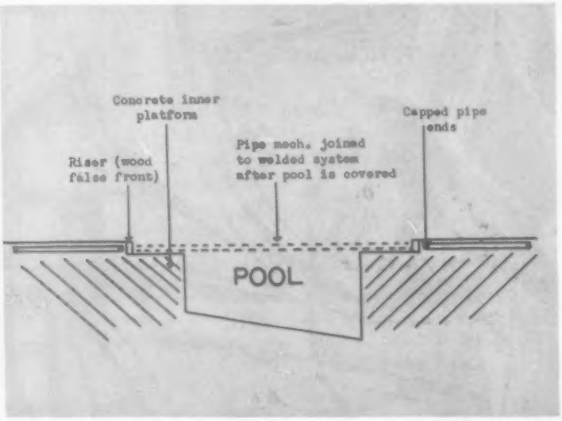
Since the network of pipes surrounds the pool, it will be covered with concrete to serve as a platform. Pipes will be $1\frac{1}{2}$ in. below the concrete's surface. An inner oval platform of concrete adjacent to the pool is about 9 in. lower than the pipe-lined outer concrete. The vertical (or riser) portion between the two levels is actually a false front of wood, which can be removed to get at those pipe sections interrupted by the pool and inner area.

These pipe ends are mechanically capped during the summer and form the inside periphery of the welded system.

When the swimming season ends, the extra piping necessary to complete the rink's system will be installed within this center portion over the inner platform and pool. (The pool will have been covered by them.)

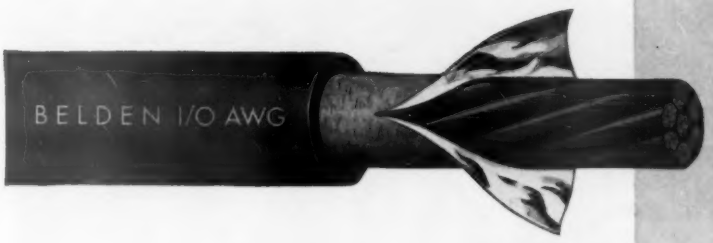
With the approach of warm weather, these mechanically joined sections will be taken apart and the inlaid open ends recapped. The process will be repeated with subsequent seasonal changes.

BRINE-carrying system of pipes was undergoing leak test when this photo was taken. Concrete was later poured over piping. Background: portion of the $2.5 million motel.

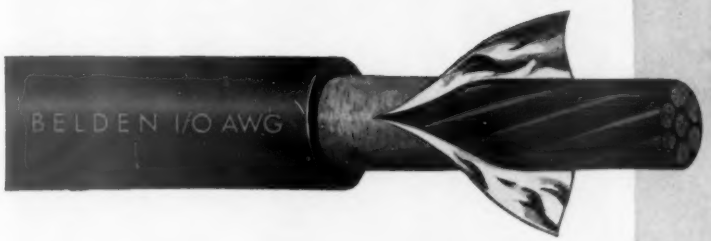

Concrete inner platform
Capped pipe ends
Riser (wood false front)
Pipe mech. joined to welded system after pool is covered
POOL

CUT-away side view of pool-rink.

Belden Welding Cable
the Complete Line

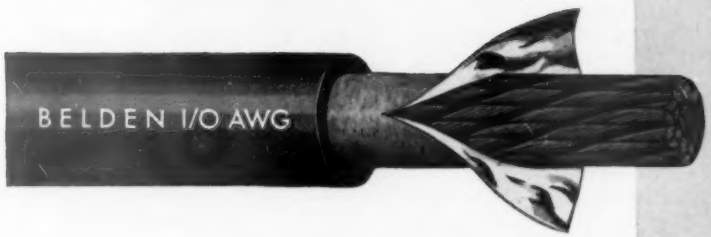


O.T.R. Rubber-Jacketed Cables
Oil-tempered rubber gives the best balance between easy handling, flexibility, and resistance to the effects of oil, heat, cold, and mechanical abuse.



Neoprene-Jacketed Cables
Resist oil, grease, heat, sunlight, mechanical abuse, and ozone set up by high frequency welding or atmospheric conditions.

HVF Vinyl Plastic-Jacketed Cables
High voltage-frequency vinyl insulation affords perfect resistance to corona and ozone cracking . . makes this cable ideal for high frequency welding. High resistance to abrasion, oil, and impact.



Whip Lead Cables
Hawser lay construction of conductor makes this cable extremely limp and manageable .. minimizes operator fatigue. Jacket won't pull away from electrode holder. Neoprene insulation.

plus rubber-jacketed welder power supply cords

ask your welding supply distributor

one wire source for everything electrical and electronic

magnet wire • lead wire • power supply cords • cord sets • portable cordage • electronic wire • automotive replacement wire and cable • aircraft wire • electrical household replacement cords

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
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18-1-9

This New **PLUG-IN** Welder Control

Lets You

ADD CONTROL FUNCTIONS AS YOU NEED THEM

A Wide Range of Plug-In Units Enables You to Add Components as Your Welding Jobs Change

HERE'S HOW YOU CHANGE YOUR BASIC CONTROL SIMPLY BY ADDING PLUG-IN UNITS

FOR WELDING MILD STEEL— BASIC CONTROL INCLUDES THESE PLUG-IN UNITS:

3B Timer
Relay Valve Control
Tube Firing Panel

FOR WELDING ALUMINUM— YOU ALREADY HAVE:

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Tube Firing Panel

YOU ADD THESE PLUG-IN UNITS:

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- 22 standard units provide "custom" control for every welding requirement
- all units are plug-in type for quick change
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Write for Bulletin SM-277 to Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

a frank report

by **A.O.Smith**

on new techniques and new equipment for the most advanced automatic and semi-automatic CO_2-shielded welding processes.

who's who in CO_2

. . . and from **A.O.Smith . . . .**

C-OMANUAL

C-OMATIC

C-OMANUAL BUTTON WEL

YES! Gun-trigger welding speed

Operator works with a visible arc, welding joint always visible, no excuse for misplaced welds. The CO_2 "gun" or "head" automatically compensates for arc length, puts down metal at rates up to 30 lbs./hr. Work is never interrupted by a need to chip slag or clean flux. Just pull the trigger (or push the button) and you're off!

YES! New production flexibility

A. O. Smith CO_2 processes can be used on a wide range of gages, from approximately 0.075-inch to 1½-inch plate, on fillet, lap, butt welds, or for steel casting repair. Simplicity of operation coupled with high weld quality leads to many new applications. Operator enthusiasm for the process keeps production jobs rolling.

advantages with CO_2 ?

YES! Substantial cost savings

Process efficiency depends, of course, on proper application. When the application is right, the exceptional deposit rates, the low cost of CO_2 compared with that of other shielding gases, and the low gas consumption rate—add up to substantial savings.

YES! Strength and ductility

Use of CO_2 (carbon dioxide gas) as a shielding envelope produces welds that are strong and ductile. Extensive tests and field applications prove that the CO_2 processes are here to stay — for low-cost, high-speed welding of mild and medium carbon steel.

3 CO_2 *welding processes!*

A semi-automatic hand-gun process.

Consists of a 600-amp Constant-Potential power source; an integrated wire-drive unit; a lightweight, perfectly balanced hand gun.

A fully automatic process.

For high production mild steel welding. Consists of exceptionally efficient and dependable 600-amp CP power source; control panel; fully automatic welding head.

DER **A semi-automatic hand-gun process.**

Consists of the basic C-OMANUAL equipment, with the addition of a cycle timer and specially designed nozzle fittings. Produces button welds of all types with speed and quality.

Let's look at this A.O.Smith C-O manual !

what?

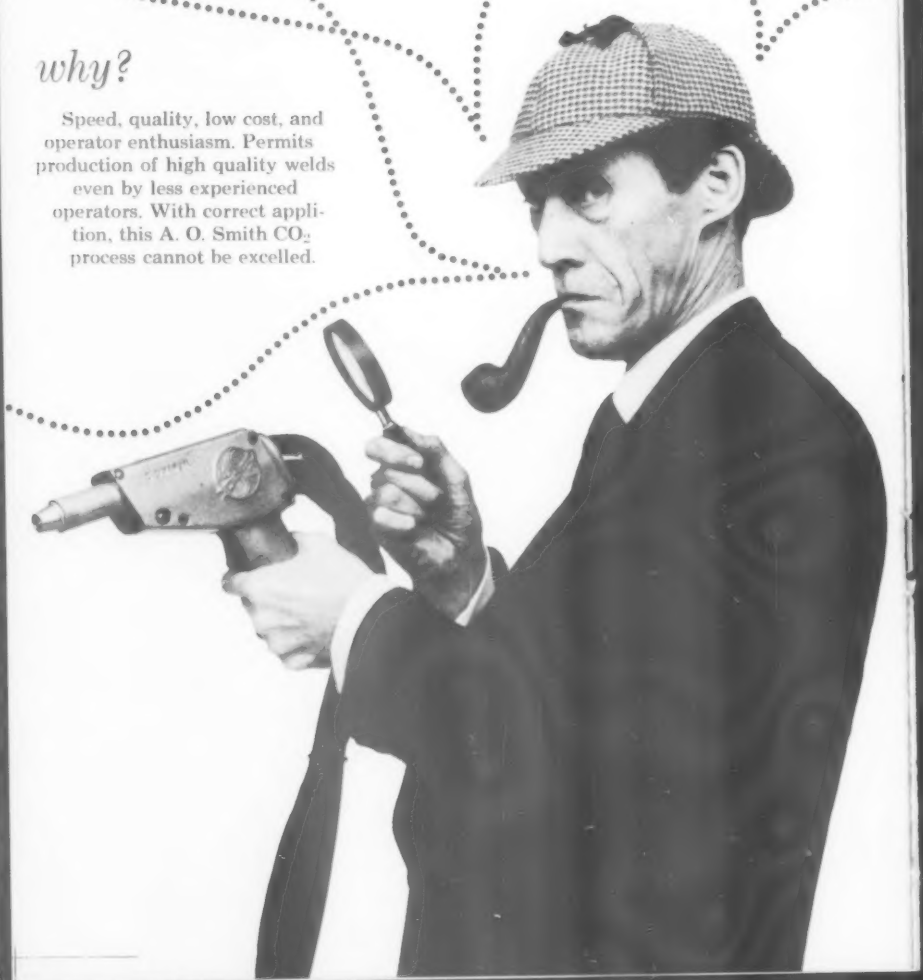
a semi-automatic hand-gun welding process that uses CO_2 as a shielding envelope with specially developed CO_2 wires . . fast, flexible, money-saving.

how?

The operator sets his voltage and wire speed, positions his gun, and pulls the gun trigger. That's all there is to it. Visible arc assures weld quality.

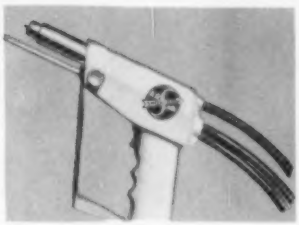
why?

Speed, quality, low cost, and operator enthusiasm. Permits production of high quality welds even by less experienced operators. With correct appli-tion, this A. O. Smith CO_2 process cannot be excelled.



GUN

Featherweight, pistol-grip hand gun (includes hose and cable assembly) — as easy to use as pointing a finger. Water-cooled, without "O" rings, it eliminates leakage troubles. All connections are fully protected. Changing wire sizes is fast and simple.



WIRE DRIVE UNIT

Can be mounted on top of power source. Consists of mechanically governed wire feed motor, gear-motor for remote wire feed speed change, dual drive wire feed rolls, post-purge gas and water timer and solenoids, safety water pressure switch, control relays.

POWER

A. O. Smith 600 amp continuous duty CP welder. Slope Control provides tap switch adjustment of output characteristics from very flat (.6 volts per 100 amperes droop) to very drooping (8 volts per 100 amperes) slope. Widest voltage range, 0 to 45.4 volts at rated load. Built-in 2 KVA—115-230 volt control transformer provides power for accessories. Fixed 180 amp connection for stick electrode tacking.

WIRE LOADING

As easy as changing a record on your record player. A. O. Smith automatic welding wire designed specifically for use with CO_2, takes only a few minutes to change. Keeps the job rolling with minimum downtime. Wire is available in reels, coils, Pay-off Paks.

THE "PACKAGE"

The complete package consists of the 600 amp Constant Potential power source, wire drive unit and hand gun, connected to the wire drive unit by gas and water hose, water cooled welding power cable, wire feed conduit cable and remote control switch. Also included are wire drive swivel mount and power cable.

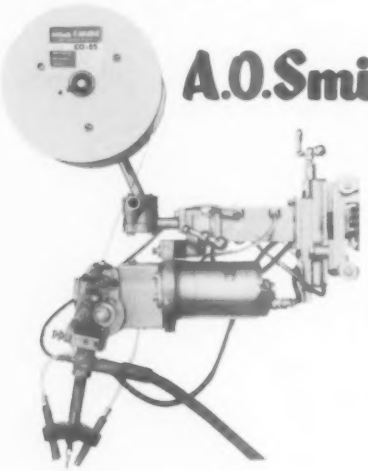
Optional equipment includes: Cooling water recirculator, CO_2 pressure regulator and flowmeter, and Stellarweld reactor which provides a variety of arc characteristics for various applications.

C-OMATIC . . . is the original fully automatic CO_2 welding process, offering all of the many advantages of CO_2 welding plus a history of automated performance unmatched in industry. Many units installed and operating every day are your assurance of satisfaction.

Primary C-OMATIC components consist of an A.O. Smith 600 ampere Constant Potential power source; compact control panel; and rugged automatic head. Secondary components include all necessary gas, water and power cables; a choice of specially designed CO_2 welding wires in any diameter and package size; all necessary fittings, gages, etc.

"*Just a voltage adjustment . . .* on the A. O. Smith 600 ampere Constant Potential power source. Two knobs on the front of the unit provide "coarse" and "fine" voltage to fractions of a volt. Slope Control provides additional voltage regulation to fit any job requirement."

A.O.Smith C-Omatic..



AUTOMATIC HEAD feeds weld wire ($\frac{1}{32}$-in. to $\frac{5}{32}$-in. sizes) at speeds to match job requirements. Simple adjustment for variations in the wire's lead and trail positions.

CONTROL PANEL is a portable pushbutton station for automatic operation of the welding head. Has vernier wire adjustment. Mounts easily anywhere in view of operator. Controls, stop, start, inch-up, inch-down, amperage and wire-feed speed.

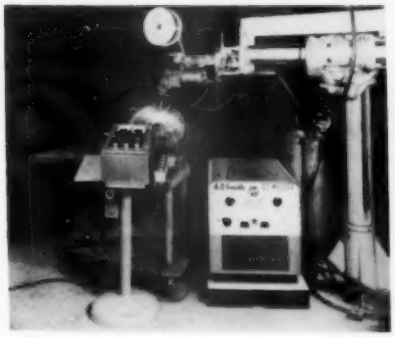
Two heads **are** better than one!

"*Just set one knob . . .*
on the compact control panel. A twist of the wrist takes care of both amperage and wire feed speed. Heavy duty start-stop buttons, a variable crater fill control, voltmeter and ammeter dials make this the simplest and most foolproof unit in the industry."

"*That's all there is to it!*
Push a button and go. Automatic head was designed for high speed production where downtime is costly. Connections are all plainly marked and keyed. Head has infinite number of adjustments. And reel changing takes only a few seconds."

full automation for CO_2 welding

POWER SOURCE is full 600-amp CP welder with the widest voltage range available — 0 to 45.4 volts. Instant striking, no sticking. Slope Control for infinite adjustment.



COMPLETE "PACKAGE" for the A. O. Smith C-OMATIC process includes CP power source, remote control panel, automatic welding head, nozzle, three position mount and all necessary hoses, cables and fittings.

TWO C-OMATIC HEADS MOUNTED FOR SIMULTANEOUS WELDING

Automotive front cross bar longitudinal weld, with the heads mounted in the 3 and 9 o'clock positions. The irregular shaped piece is rotated between the heads. At the high speed of travel (185 ipm vs. 50 ipm hand arc), the wire alignment to the seam is critical; therefore electronic tracers have been incorporated into the fixture to assure proper alignment. Tacking was eliminated.

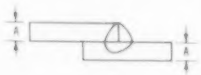
See following pages for
*Application Charts
*Physical Data

A.O.Smith

C-O manual
C-O matic

APPLICATION DATA CHARTS

LAP JOINTS



Stock Thickness A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
1/16"	3/64"	260/300	28-30	100-120	10-15° D.H.	12-19	0-10° trail
	1/16"	390/420	24-31	140-160	10-15° D.H.	12.5-17	0-10° trail
	3/64"	240/300	26-30	110-130	Flat	11-19	0- 5° lead
1/8"	5/64"	580/600	30-32	120-150	10-15° D.H.	21-28	0-10° trail
	1/16"	450/520	29-32	150-160	10-15° D.H.	18-24	0-10° trail
	1/16"	380/420	26-30	70-90	Flat	12-17	0- 5° lead
3/16"	1/16"	420/480	29-32	40-60	0-5° D.H.	17-20	0-10° trail
	5/64"	480/540	29-32	50-70	0-5° D.H.	17-21	0-10° trail

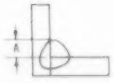
A. O. Smith automatic wire No. CO-86 was used in all the above instances.

HORIZONTAL LAP JOINTS

Stock Thickness A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
1/8"	1/16"	440/480	27-32	80-120	10-15° D.H.	16-20.5	0 to 8° trail
	5/64"	480/500	28-30	130-160	10-15° D.H.	17-21	0 to 8° trail
3/16"	1/16"	420/480	27-32	60-100	10-15° D.H.	17-20	0 to 8° trail
	5/64"	540/590	28-32	90-140	10-15° D.H.	21-27	0 to 8° trail

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

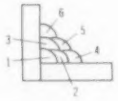
HORIZONTAL FILLETS



Fillet Size A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
1/8"	1/16"	340-380	32-34	35-45	Flat	10-14	Nozzle at 45°
1/4"	1/16"	350/400	32-34	30-40	Flat	12-16	Nozzle at 45°
5/16"	1/16"	360/420	32-36	25-35	Flat	13-17	Nozzle at 45°
3/8"	1/16"	360/420	34-38	15-20	Flat	13-17	Nozzle at 45°

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

HORIZONTAL FILLETS MULTI-PASS



Layer	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
1	1/16"	360/420	32-35	20-25	Flat	13-17	0-5° trail
2	1/16"	370/430	33-37	25-30	Flat	13-17	0-5° trail
3 etc.	1/16"	370/430	33-37	25-30	Flat	13-17	0-5° trail

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

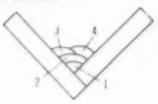
POSITIONED FILLETS

Fillet Size A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
1/4"	1/16"	420/440	35-38	25-30	Flat	14-19	0-10° trail
3/8"	1/16"	460/480	38-42	20-30	Flat	15-22	0-10° trail
1/2"	1/16"	500/520	38-42	15-18	Flat	18.5-25	0-10° trail

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

Take a close look at some typical CO_2 applications

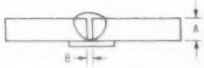
POSITIONED MULTI-PASS FILLETS



Layer	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr
1	1/16"	500/520	40-42	15-18	Flat	18.5-25
2	1/16"	500/520	40-42	10-15	Flat	20-26
3 & 4	1/16"	500/520	40-42	15-20	Flat	18.5-25

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

BUTT WELDS (Steel Back-up)



Stock Thickness A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Gap B	Dep. Rate Lbs/Hr	Penetration
1/8"	1/16"	430/450	29-32	65-75	Flat	0	14	100%
3/16"	1/16"	490/510	32-35	45-55	Flat	0	18	100%
5/16"	1/16"	550/570	32-35	40-50	Flat	0	22	100%
3/8"	1/16"	560/580	31-34	40-45	Flat	1/16"	23	100%

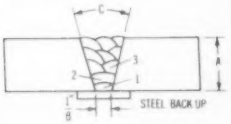
A. O. Smith automatic wire No. CO-86 was used in all the above instances.

BUTT WELD (Both Sides)

Stock Thickness A	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Notes
3/8"	1/16"	410/430	32-36	20-25	Flat	12-16	Weld on both sides at the same conditions
1/2"	1/16"	480/500	32-36	15-20	Flat	16-19	Same conditions

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

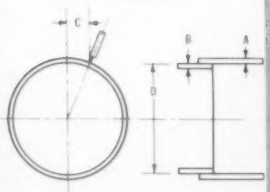
SPACED "V" BUTT WELDS



Stock Thickness A	Layer	Wire Dia.	Amps	Volts	Travel Speed IPM	Weld Position	Dep. Rate Lbs/Hr	Angle C
3/8"	1	1/16"	420-480	29-31	15-18	Flat	16-22	30°
5/8"	1 & 2	1/16"	420-480 420-480	29-31 29-31	15-20 20-25	Flat Flat	16-22 16-22	30°
3/4"	1	5/64"	440-520	37-40	10-15	Flat	17-23	60°
to	2	5/64"	450-480	35-38	7-10	Flat	17-23	60°
1-1/2"	3 etc.	5/64"	450-480	35-38	10-15	Flat	17-23	60°

A. O. Smith automatic wire No. CO-86 was used in all the above instances.

CIRCUMFERENTIAL LAP WELDS



Stock Thickness A	Stock Thickness B	Amount of Flood C	Dia. D	Wire Dia.	Amps	Volts	Travel Speed IPM	Dep. Rate Lbs/Hr
.088"	.154"	2-7/8"	12"	5/64"	550/560	30	120	19
.088"	.147"	2-5/8"	14"	5/64"	530/540	30	100	18
.101"	.161"	3"	16"	5/64"	570/580	30	100	20.5
.113"	.187"	3-3/8"	18"	5/64"	580/590	30	100	21
.123"	.204"	3-1/2"	20"	5/64"	600/610	31	100	23

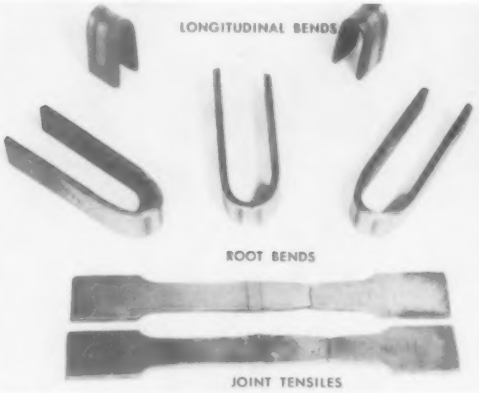
A. O. Smith automatic wire No. CO-86 was used in all the above instances.

Examine these A.O.Smith

A. O. Smith C-OMANUAL and C-OMATIC processes produce x-ray quality, low-hydrogen welds with mechanical properties equal to the best produced with coated electrodes.

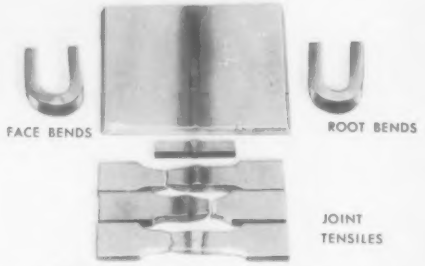
Single Pass Butt Welds

— in A-285 steel. Face and root bends indicate superior ductility. Cross section of the butt weld shows extent of penetration. Radiographs easily passed Class 1 Boiler Code standards.



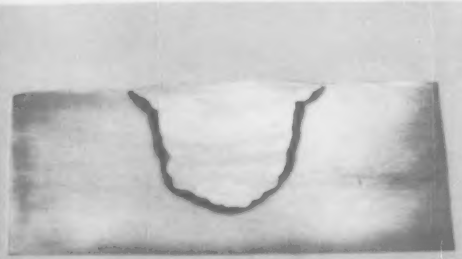
Double Pass Butt Welds

— in $\frac{5}{8}$" medium carbon steel. Face and root bends indicate excellent ductility. Sufficient strength also, as joint tensiles failed in the stock at about 85,000 psi.



HIGH-SPEED CASTING SALVAGE

Foundries are building up blowholes and other imperfections in castings at high speed and low cost with A. O. Smith C-OMANUAL welding. Operators put down metal at rates up to 30 lbs. an hour, compared with 10 pounds or less with manual welding. Deep penetration and weld quality are assured. No flux or slag to chip. Operator can start at the bottom and work to the top without stopping.



FILLED BLOWHOLE IN CASTING

(Cross Section)

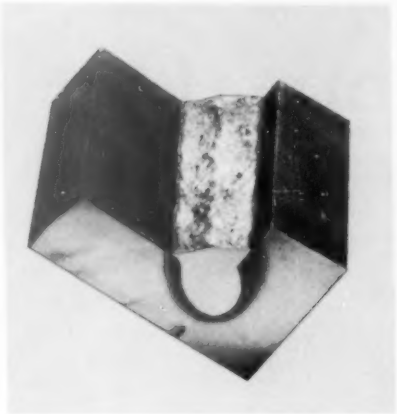
Built-up blowhole in a salvaged foundry casting is 4½" deep and 6" in diameter. On jobs like this, A. O. Smith C-OMANUAL puts down weld metal much faster than conventional electrodes.

CO_2 physicals, too

TYPICAL MECHANICAL PROPERTY TESTS

As-Welded, Not Artificially Aged

A. O. Smith Wire	Type Weld	Yield Strength	Tensile Strength	% Elong.	Red. of Area
CO-86	Butt	58,000	73,000	30.0	62.3
		60,500	72,000.	28.5	61.8
CO-85	Butt	54,800	72,400	30.5	64.5
		54,300	71,900	30.5	64.9

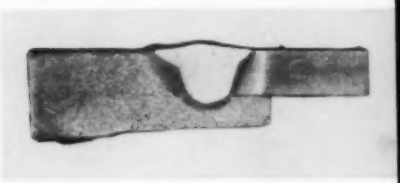


◀ POSITIONED FILLET

Single layer fillet weld deposited in ¾"-thick ASTM A-285 steel. Note depth of penetration and smooth surface appearance of the weld. A. O. Smith 1/16" CO-85 wire was used at 470 amps, 40 volts.

BEND TEST RESULTS

Welds made with the CO_2 processes were entirely satisfactory after bending to 180°. Tests proved that weld metal of excellent ductility are obtained.



▲ PENETRATION

Welds made with A. O. Smith C-OMATIC and C-OMANUAL have a wide and well-rounded weld penetration, as this photograph clearly shows.

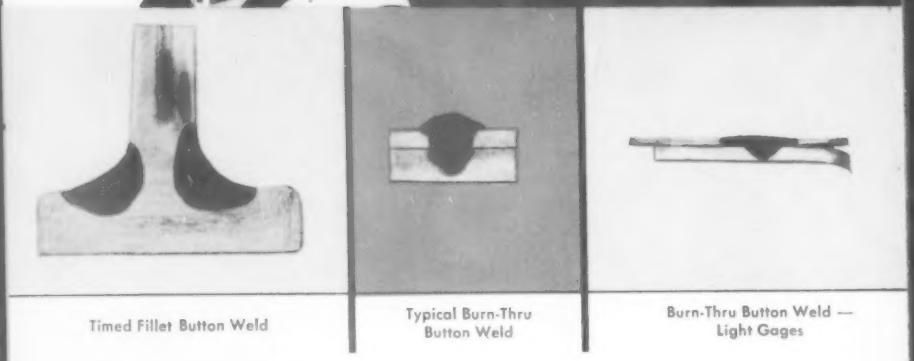
HIGH PRODUCTION SET-UP

C-OMANUAL in use on X member crossbar of an automotive convertible frame. This is a high production set-up where the operator is, in effect, making an I-beam section — welding two siderails on a center web. Work is positioned for downhill (20°) welding. Speeds between 100 and 200 ipm are achieved. Work requires NO degreasing or cleaning. Slag cleaning eliminated. Virtually no rejects.

A. O. SMITH AUTOMATIC WELDING WIRE

Designed specifically for top performance CO_2 welding on a wide variety of steels. Available in many diameters, packages and types.

NEW *from* A.O.Smith



Timed Fillet Button Weld

Typical Burn-Thru Button Weld

Burn-Thru Button Weld — Light Gages

Here is how you do it...

"Just slip the right button-weld nozzle over the C-OMANUAL gun barrel, tighten up the clamping screw, and the operator is set to go."

"To make a button weld, he positions the nozzle on the work, pulls the trigger, holds it until the automatic timer stops the welding. No helmet needed!"

...Button welding with a hand gun!

- A finished weld that resembles a button or rivet head.
- Made with a lightweight hand gun using the CO_2 C-OMANUAL process.
- No special training or skill required of the operator.

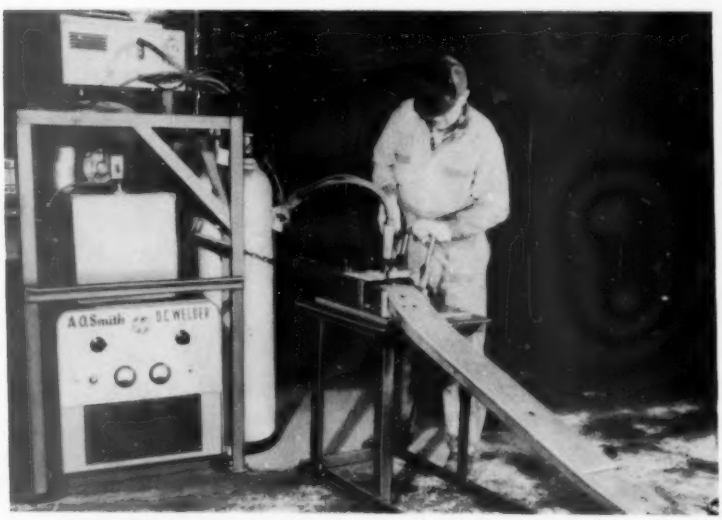
Button welding can best be described as an economical and improved substitute for spot (resistance) welding and riveting with applications far beyond those two processes.

Employing the basic C-OMANUAL equipment (see pages 4 and 5) plus a Button Welder Adapter Kit consisting of a choice of nozzles and a cycle timer, the operator merely positions his gun on the work, pulls the trigger and holds until the welding stops — automatically. Cycles can be varied from three (1/20th second) to 360 (6 seconds) depending on stock thickness (3/64" to 3/16").

Wire feed rolls are designed to feed weld wire without wire distortion. Each unit is shipped with dual wire feed rolls, including one spare, for driving 1/16" diameter wire. Rolls for 3/64", 5/64" and 3/32" diameter wires are also available.

Any of the standard joints can be button welded (lap, fillet, butt, etc.) without a need for special operator training or skills. And every "button" is exactly the same — as pre-set on the timer. There's no flux to clean — no need for a welding helmet. Operators love it.

The button weld process gives high quality weld metal, high deposition rates, deep penetration, low hydrogen weld metal, visible arc, no slag removal, and low overall costs.



No Possibility of Operator Error

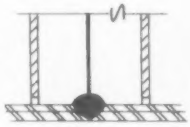
Button-welding a reinforcement bracket with the A. O. Smith CO_2 process. In this case five button welds are grouped in a relatively small area, with a simple aperture fixture used for positioning. Steel gages are 0.109 for the top piece and 0.145 for the lower piece. Each weld requires approximately one-half second (30 cycles), which is pre-set on the automatic timer. Any possibility of operator error is eliminated. Amperage: 420 at 39 volts. Visible weld, and no cleaning or degreasing of work necessary. The operator requires no helmet.

Be right on the "button" the

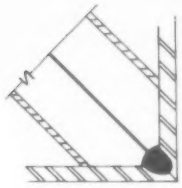
Slip-on Nozzles For Different Joints

Nozzles for burn-through button welds and fillet tack welds along with the cycle timer, are furnished with each "Button Gun" kit.

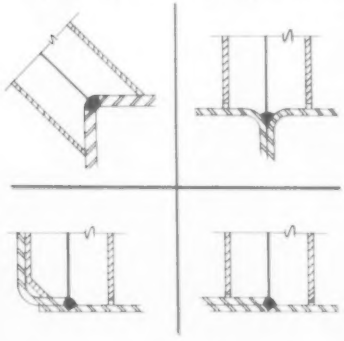
1. Standard burn-through button weld nozzle



2. Fillet Tack Button Weld Nozzle



Special nozzles for varied applications can easily be made to suit your job requirements.



A.O.Smith way

Reliability of weld quality even on uncleaned steel, extreme flexibility, and low cost of operation make A. O. Smith's CO_2 button gun a valuable new high-speed production tool. Note that it is ideal for tacking. No skill on the part of the operator is required: the supervisor sets the cycle, the operator positions the nozzle, pulls the trigger, and gets a perfect button weld every time.

CO_2 BUTTON WELDS

Stock A	Stock B	Wire	Amps.	Volts	Cycles
.081	.081	1/16"	380	37	23
.089	.089	1/16	360	37	25
.119	.119	1/16	390	37	30
.142	.142	5/64	460	40	33
.195	.195	3/32	460	47	75
.215	.215	3/32	465	48	98

CO_2 EDGE BUTTON WELDS

Stock A	Stock B	Wire	Amps.	Volts	Cycles
.081	.081	1/16"	280	40	23
.081	.081	3/64	200	37	42
.089	.089	1/16	290	40	23
.089	.089	3/64	200	37	35
.119	.119	3/32	370	37	35
.136	.136	1/16	350	37	40
.183	.183	1/16	380	37	42

Button Welding Doubles Production

Photo (at left) shows an operator button-welding a cover plate to a control arm. This job was formerly hand-arc welded at a rate of 2,200 pieces per shift. Using the button gun, the rate was upped to 4,800 pieces per shift. From 5% to 8% of the parts manually welded required repair. Only ½ of 1% of the button-welded parts required repair.

On this job two button welds are made on each piece (0.180 to 0.180 stock thickness) at ½ second each; 425 amps at 39 volts.

An interesting sidelight concerned a job requirement of 1/16" maximum button height. Problem was solved by drilling a ¼" hole in the top piece and actually inserting the wire of the button gun in the hole. The result was a virtually flat button.

YOU KNOW THIS MAN . . .

sure you do! You've seen him in the movies, on television, and perhaps on the stage. John Carradine — a star in all three mediums. During a visit to Milwaukee, he visited A. O. Smith, discovered the dramatic art of welding, and got right into the middle of it.

IF YOU have a role in which CO_2 welding can play a great part, and you want to see a try-out — call your "man from A. O. Smith."

a frank report

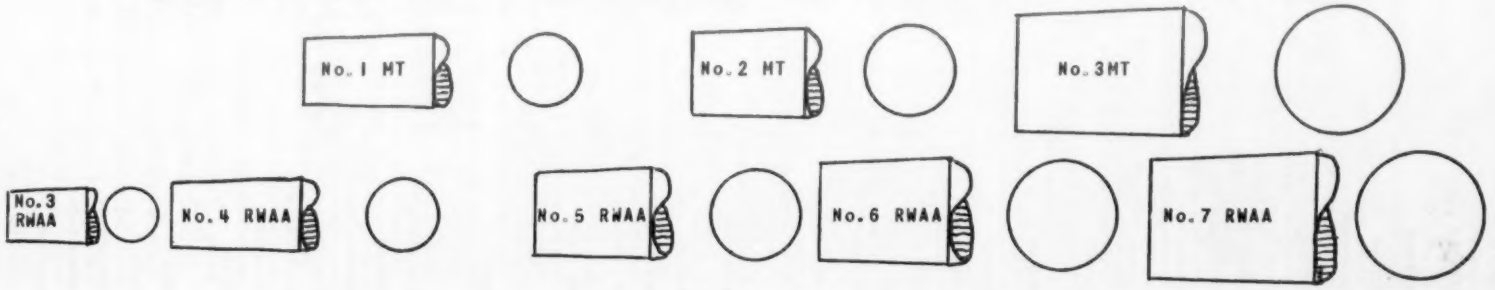
by **A.O.Smith**

on new techniques and new equipment for the most advanced automatic and semi-automatic CO_2-shielded welding processes.

see what you can do with CO_2

If you have a problem in welding automation, remember — A. O. Smith C-OMATIC for the welding equipment and A. O. Smith Engineering Service Corporation for the fixture. There's no job too complicated and there's only one responsibility.

Proposed RWAA numbering system for R-W electrodes



TAPER PER FOOT 600" UNIFORM ON ALL SIZES ANGLE- 1° 25 56"

No. 3 RWAA 3/8 Dia.	No. 4 RWAA .482 to .500 Dia.	No. 5 RWAA 5/8 Dia.	No. 6 RWAA 3/4 Dia.	No. 7 RWAA 7/8 Dia.
Taper Length 1/2"	Taper Length 7/8"	Taper Length 3/4"	Taper Length 7/8"	Taper Length 1-1/8"
Taper Engagement 3/8"	Taper Engagement 1/2"	Taper Engagement 3/4"	Taper Engagement 7/8"	Taper Engegement 1-1/8"
Dia. 3/8" from end .355 .001	Dia. 1/2" from end .463 .001	Dia. 1/2" from end .613 .001	Dia. 1/2" from end .731 .001	Dia. from end .844 .001
Dia. Water Hole 1/4"	Dia. Water Hole 9/32"	Dia. Water Hole 3/8"	Dia. Water Hole 7/16"	Dia. Water Hole 1/2"

Numbering to follow along the old R.W.M.A. system with the desirable features of the Jarno Taper such as having a definite relationship to the physical features of the electrode and a uniform taper per inch.

The Jarno System of taper measurements is based on the diameters of the large end of the taper in increments of 1/8" as the dimension that mostly concerns us. We could number the tapers progressively as follows: No. 3 - 3/8 Dia.
No. 4 - 1/2 Dia. or .482 as now used
No. 5 - 5/8 Dia.
No. 6 - 3/4 Dia.
No. 7 - 7/8 Dia.

This gives us two more tapers than before namely #3 and #6.

The designation of Styles to remain as before
A - Pointed Nose B - Dome Nose C - Flat Nose D - Offset Nose

Numbers to be designated as follows

TYPE NOSE	CLASS OF ALLOY	RWAA TAPER	LENGTH IN INCREMENTS OF 1/4"
		5X1/8 = 5/8	12 = 12X1/4 or 3" long
"A"	2	#5	

L. J. LYTIKAINEN, right, instructs student in pipe welding procedure.

STUDENTS work at two tables set up for gas welding instruction.

Upper Michigan school supplying area with weldors

by **Elmer J. La Branche**

AFTER WELDING around the Upper Peninsula of Michigan for close to 20 years, it became evident to Lauri Lytikainen that there were very few skilled weldors in the area. In 1955, Lytikainen decided to try his hand at remedying the situation—he started a welding school.

He didn't have much capital, or any experience in teaching, but by talking with fellow tradesmen, he thought he detected a desire to learn more about the trade they were following.

When a riding master moved his horses out of a small stable near the outskirts of Marquette, Mich., Lytikainen moved his welding school in.

The cement floor and masonary walls minimized the fire hazard and were sturdy enough to pass the inspection of the city fire marshall and health inspector.

An 8 by 10 ft section, formerly a hay mow, was converted into an office and storage area for supplies. Three second hand welders were purchased, and stacked to conserve space. To eliminate ground clamps, a 3-in. strip of metal was run from the machines along the floor to six home-made welding tables fitted with racks for electrodes, and places for holder and hammer. Sliding curtains were hung to separate students.

Opposite the arc welding booths two tables were constructed for gas welding instruction. Gas and oxygen cylinders were attached to beams.

The next step was to have the course, project and building examined. Everything was authorized, and a schedule was planned. The school started with two groups, one coming in for four hours on Monday, Tuesday and Wednesday nights, the second coming on Thursday and Friday nights and Saturday morning.

Now the real problem came. The school had to attract students. An advertising campaign was started on local television and radio stations and in the local newspapers.

Students started to come, most of them weldors' helpers and general laborers who wanted to upgrade themselves. Others came from the Veterans Administration, local dock company, U. P. Power Co., the mines and neighboring cities, and the State Division of Vocational Rehabilitation, which trains disabled persons.

For the first year the school was able to break even. The advertising was kept up, the students themselves spread the word, and enrollment increased.

Due to his experience as a weldor, Lytikainen knew most of the welding foremen in the area. He was able to place a few students on jobs, and once others saw that jobs could be had after attending the school, they came in faster.

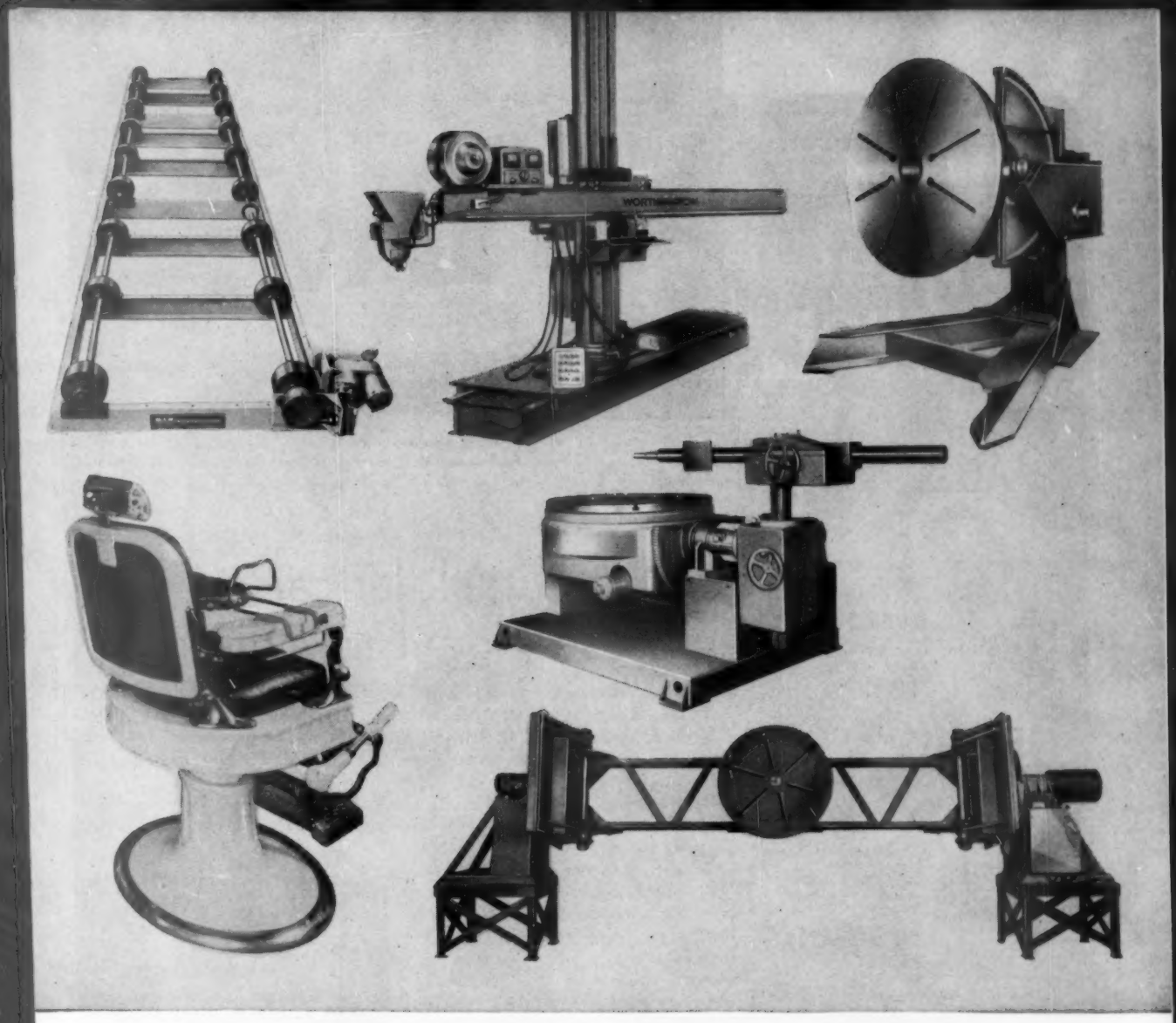
In three years the school has paid off the building. Lytikainen has installed an area for contract welding on his own.

To start a welding school, Lytikainen says, ". . . go slow at first. Don't invest too much money. . . . Like any business, you must build from the ground up to make it pay."

FREE DEMONSTRATION

Many of the Worthington distributors listed below have welding positioners in stock. Ask for a free demonstration.

ALABAMA
Ebbert & Kirkman Co.—BIRMINGHAM
ARIZONA
Arizona Welding Equipment Co.—PHOENIX
CALIFORNIA
W. H. Douthitt Steel & Supply—EL CENTRO
Anderson Equipment Co.—LOS ANGELES
Heidt Equipment Co.—OAKLAND
Moore's Welding Supply—SACRAMENTO
G. S. Parsons Co.—SAN DIEGO
A. G. Pond Co.—SAN JOSE
COLORADO
U. S. Welding Works—DENVER
CONNECTICUT
Zane Weldcraft Supplies—HARTFORD
FLORIDA
Kennerla Welding Supply Co.—MIAMI
GEORGIA
Keenan Welding Supply—ALBANY
Pye Barker Welding Supply Co.—ATLANTA
Savannah Oxygen & Supply Co.—SAVANNAH
ILLINOIS
Machinery & Welder Corp.—CHICAGO
A. E. Dailey Co.—MOLINE
H. R. McGarvey—PEKIN
INDIANA
Allied Weld-Craft—INDIANAPOLIS
C. A. Schrader Co.—MISHAWAKA
KANSAS
Lampton Welding Supply Co.—WICHITA
LOUISIANA
Woodward, Wight & Co.—NEW ORLEANS
MAINE
Maine Oxy-Acetylene Supply Co.—AUBURN
MARYLAND
Air Reduction Sales Co.—BALTIMORE
MASSACHUSETTS
Welders Supply Co.—BURLINGTON, CAMBRIDGE and WORCESTER
G. L. Merriam Co.—GREENFIELD
MICHIGAN
Robinson Welding Supply Co.—DETROIT
Mackay Industrial Sales—GRAND RAPIDS
Lake Welding Supply Co.—MUSKEGON
Tupes of Saginaw—SAGINAW
MINNESOTA
W. P. & R. S. Mars Co.—DULUTH
N. R. Toll Co.—MINNEAPOLIS
MISSOURI
McDonald & Wilson Sales Co.—ST. LOUIS
NEW HAMPSHIRE
N. H. Welding Supply Co.—MANCHESTER
NEW JERSEY
Mid-Jersey Equipment Co.—LIVINGSTON
Essex Welding Co.—NEWARK
NEW YORK
Mills Welding Supply Co.—BUFFALO
Le Valley McLeod Inc.—ELMIRA
Jackson Welding Supply Co.—ROCHESTER
Cotte Welding Supply Co.—SYRACUSE
General Welding Supply Corp.—WESTBURY
OHIO
Obiva Welding Co.—CINCINNATI
Scott-Tarbell, Inc.—CLEVELAND
World Electric Co.—CLEVELAND
Welders Service Co.—TOLEDO
OKLAHOMA
Oklahoma Oxygen Co.—TULSA
OREGON
J. E. Haseltine & Co.—PORTLAND
PENNSYLVANIA
Boyd Welding Co.—ERIE
Air Reduction Sales Co.—PHILADELPHIA and PITTSBURGH
SOUTH CAROLINA
Industrial Welding Supply—CHARLESTON
TENNESSEE
Oxygen Service Co.—KINGSPORT
TEXAS
Big Three Welding Supply Co.—BEAUMONT, DALLAS, EL PASO, FORT WORTH, HOUSTON, LONGVIEW, and SAN ANTONIO
UTAH
Whitemore Oxygen Co.—SALT LAKE CITY
VIRGINIA
Jones Welding Supply Co.—ROANOKE
WASHINGTON
J. E. Haseltine & Co.—SEATTLE, SPOKANE
WEST VIRGINIA
Virginia Welding Supply Co.—CHARLESTON
WISCONSIN
Machinery & Welder Corp.—MILWAUKEE
Acme, Inc.—MILWAUKEE
Van Haveren Welding Supply Co.—SHEBOYGAN
CANADA
Rudel Machinery Co.—MONTREAL, TORONTO, WINDSOR
Worthington (Canada) Ltd.—TORONTO



WHICH ONE OF THESE POSITIONERS DOESN'T WORTHINGTON MAKE?

Of course, Worthington doesn't make barber chairs. We really don't know anything about cutting hair . . . *but,* when it comes to positioning for welding, that's where we're right at home.

Whether you're talking about a small positioner for automatic welding of a sub-assembly, a 400-ton turning roll for a nuclear reactor, or a completely integrated push button package, Worthington is ready and able to serve you.

You owe it to yourself to investigate the profit-producing possibilities of positioning equipment—especially in these days of steadily rising labor costs and tight work scheduling. You get faster production, better and smoother welds, fewer accident hazards and less need for crane service. Every piece of Worthington positioning equipment is job-rated for extra capacity, easy installation, greater parts interchangeability and economical operation. And you can count on equally complete Worthington engineering service . . . before you buy, during installation, right through regular maintenance. Why not ask your nearest Worthington distributor or District Sales Office for more information on profitable positioning equipment. Worthington Corporation, Section 55-7, Plainfield, N. J. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON . . . FIRST IN POSITIONING FOR WELDING

WORTHINGTON

the fabricators
SUPER MARKET
Everything
FOR THE
O. I. SHOP

CASTINGS
Over 400 designs to choose from.

GARDEN FURNITURE
Great traffic and profit builders, many styles to choose from.

TUBING
From one tube to a mill lot.

PAINT
Specially designed for O. I. use.

WELDING RODS
Give spatter-free welds require little clean-up

MACHINE TOOLS AND SUPPLIES
Everything your shop would need.

OVER 400 CASTING DESIGNS

Orders shipped same day, by air if requested.

WRITE TODAY FOR OUR NEW CATALOG

TFC

TENNESSEE FABRICATING CO.
1442 Grimes St. Memphis, Tenn.

RUGGED underframe of "88" shows box-like center sill and side sills. Frame is part of flat car which can support two loaded 40-ft highway trailers (inset). Entire car, except for oak decking between center and side sills, is of all-welded construction.

by **G. C. Shields**
Railroad Sales Engineer, Linde Co.

Welded-steel flat cars increase piggyback efficiency

PIGGYBACK SERVICE, combining the speed of long distance rail travel and the convenience of door-to-door truck hauling, is offered by many railroads. When piggyback operations were started, converted standard-size flat cars were the first haulers. In most cases, however, such cars could handle only one trailer.

The Atchison, Topeka and Santa Fe Railroad refined the piggyback idea by producing a huge specially-designed, welded car that can accommodate two highway trailers.

These rugged flat cars, known as "88's" because of their 88-ft length, were built by Santa Fe's Topeka, Kansas, car shops. The giant flat cars have a capacity of 57½ tons, a center load limit of 38½ tons, and can carry two 40-ft trailers.

PORTION of I-beam is cut. Welding machine, on same fixture, is at right.

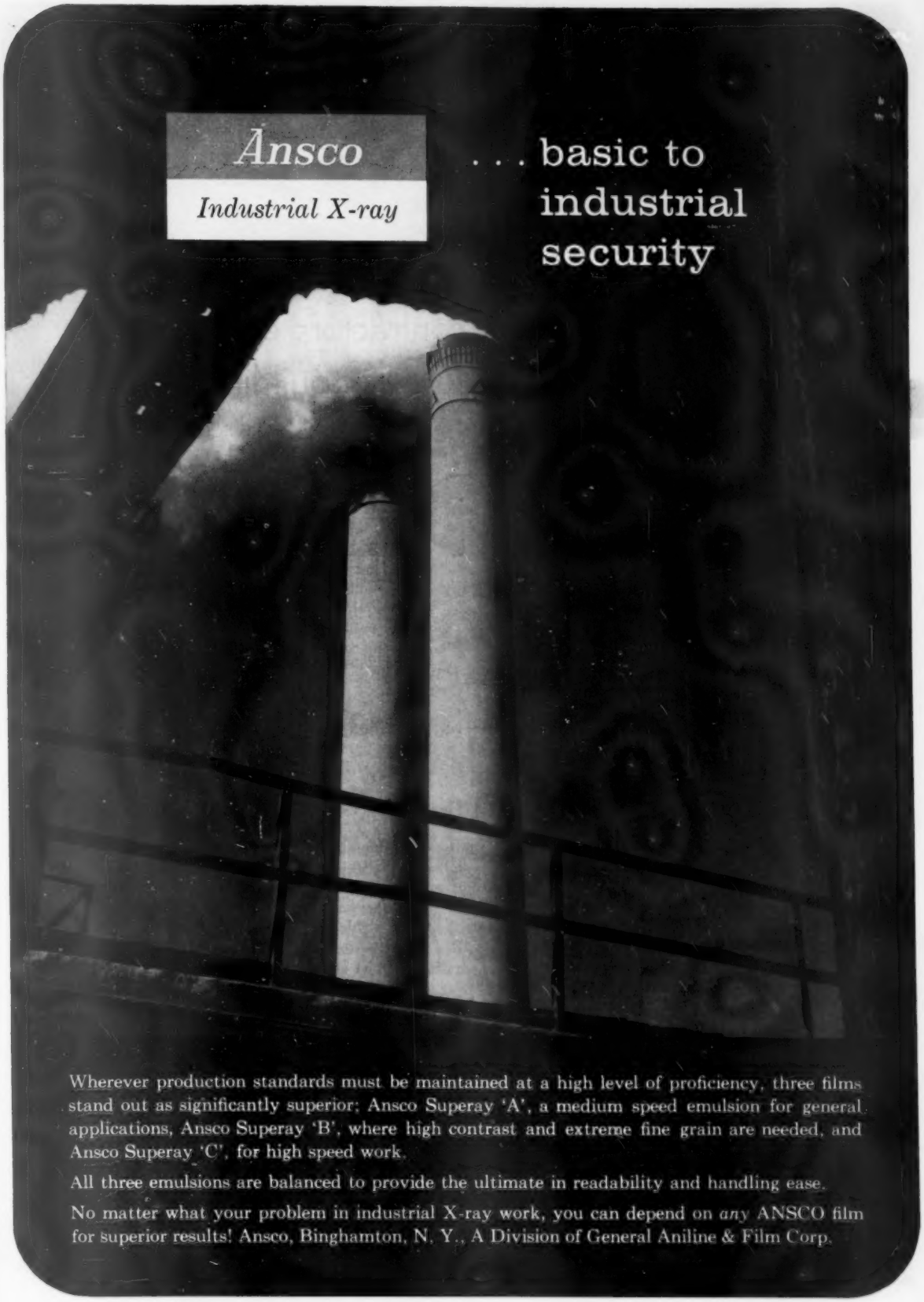
Backbone of the car is its main structural member—the center sill. Subjected to many types of stresses and heavy loads, the center sill of such a car must be extremely rugged.

The sill is formed from two 30 in. (132 lb/ft) low-alloy high-tensile steel wide-flange beams, submerged-arc welded side-by-side. Twin electrodes are used to speed welding time, and special fixtures enable the entire seam to be welded down-hand.

Side sills are made of 12-in. (35 lb/ft) steel channels. Top guide rails, constructed of 10-in. I-beams, are welded to the tops of the side sills. Crossbearers, crossties and bolster sections join the center and side sills, forming a durable all-welded, all-steel underframe.

An unusual piece of equipment is a fixture important in two operations. It holds one oxyacetylene torch and a complete submerged-arc welding machine. Use of this fixture eliminates the need for excess handling of heavy steel components and conserves floor space.

When an operator wishes to change from cutting to welding he merely turns off the torch and switches on the welding control. The welding machine incorporates a dual wire feed mechanism with two electrodes in tandem.



Wherever production standards must be maintained at a high level of proficiency, three films stand out as significantly superior: Ansco Superay 'A', a medium speed emulsion for general applications, Ansco Superay 'B', where high contrast and extreme fine grain are needed, and Ansco Superay 'C', for high speed work.

All three emulsions are balanced to provide the ultimate in readability and handling ease.

No matter what your problem in industrial X-ray work, you can depend on *any* ANSCO film for superior results! Ansco, Binghamton, N. Y., A Division of General Aniline & Film Corp.

L & G
SILVER SOLDERS

Save
TIME and MONEY

To MEET the diversified requirements of industry, Leach & Garner (since 1898) has developed a line of over 100 different silver solder alloys. Leach & Garner alloys range from those with narrow melt and flow ranges to those performing special functions, plus meeting standard specifications. An increasing number of customers are finding each Leach & Garner alloy fills a specific need with guaranteed high performance, economy, and rapid delivery.

Available mill forms: Sheet, wire, and cut. Preforms in all sizes and shapes are available on a custom basis from our affiliate General Findings & Supply Company.

For complete information and data on Leach & Garner Silver Brazing Alloys write for Technical Data Sheet No. 501.

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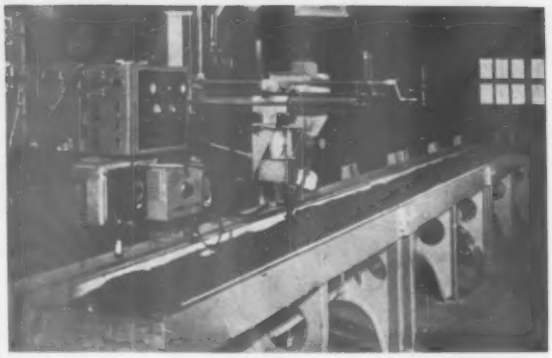

WELDING head automatically stops over link, barely exposed through hardfacing flux. If work load demands, an additional welding head and power source can be added to equipment.

Eastern contractors equip shops for own track rebuilding operations

PLAGUED BY WORN tractor tracks, and the nuisance of sending them out to be hardfaced and rebuilt, two Eastern contractors have licked the problem by installing their own equipment so quick, inexpensive repairs can be made in their own shops.

Serafini Construction Co. and Corbiscello Construction Co., both of Binghamton, N. Y., have equipped themselves with the same type of welding units and follow the same welding procedures.

Corbiscello is using a 30-ft Berkely Conserval fixture, while Serafini found the need for a 40-ft unit. Both fixtures have a 7-ft carriage beam extension, and rotator for resurfacing rollers, idlers, sheaves and other round parts.

On each fixture, an automatic submerged-arc welding head rides a beam carriage that moves over stationary work. Weld heads are powered by 500-amp, d-c arc welders. Hobart Bros. Co. equipment is used.

To start the operation, a hoist and shop-made rig lift the entire tractor track, with grouser shoes intact, onto the welding table. The time required to remove and replace grousers is eliminated in this method. The adjustable trough width is maneuvered until the track and welder travel beam are aligned.

After alignment is secured the ends of the track are blocked to prevent track motion during the welding operation. The trough is then filled with hardfacing flux, leaving the tops of the links exposed. The loose flux is needed to support the molten metal and keep it from spilling off the sides of the links. After the flux is applied, the welding sequence begins.

The welding head moves continuously over the track while the arc automatically starts and stops on each link. Because this automatic operation requires high voltage and high frequency starting, 38 to 40 volts is used to begin the sequence. This is cut to 500 amp at 25 volts during welding. A 5/32-in. diameter hardfacing wire is fed, and a travel speed of 20 ipm is maintained.

Special cams, mounted on the fixture camrail, trigger arc starts and stops. These cams can be set to resurface any make or size track. Weld length for different size links is controlled by the space between the cams, while the space between the links is governed by the effective width of the cams. Once adjusted, operation for each pass over the entire link is fully automatic.

Both contractors take advantage of the equipment's versatility by rebuilding and hardfacing tractor idlers and rollers, too. A 7-ft carriage beam extension allows the travel carriage and welding head to be moved free of the track welding table and over a rotating unit.

Rolls and idlers are held on the rotator, which is adjustable from speeds of 0 to 7½ rpm. Its heavy-duty spindle is manually adjustable from horizontal to vertical positions by means of a worm drive. A step-over timer automatically moves the welding head over the proper distance for each successive weld bead after each revolution.

Way ahead in VISION... Way ahead in VENTILATION

NEW!

AO "Kool-Vent" Face Shield (No. 283)

Ever see a face shield *like this?*

It's a real "natural" — never before have you seen a shield like it with protection, vision and comfort combined.

There's no screen before the eyes to impede vision but plenty of 24 mesh screen elsewhere for good ventilation. The clear acetate window permits unobstructed vision. Workers can do a better job. No wonder this new AO Face Shield has been enthusiastically received wherever it has been shown. It is available with clear, green or aluminized windows.

Recommended for hot operations or *any* operation where a man wants the best combination he can get of vision and ventilation.

Back headband is fiber, adjustable, fits lower head snugly, comfortably. The long band slides within a fiber sleeve — permits easy nut adjustment for head size and prevents hair pulling.

AO H-3 Face Shield

— Same as AO #283 except entire window is acetate.

AO H-1 Face Shield For operations where no standard spark deflector or forehead guard is required. Adjustable elastic headband may be worn low on head for extra comfort. Standard leather sweatband and window, snap-on type.

FEATURES — AO 283 and H-Series Face Shields

- Slotted window permits expansion and contraction. Heat won't warp or distort.
- Most models with deep spark deflector.
- All vulcanized fiber parts of rugged construction (specification thickness).
- Windows set out extra inch for clearance and ventilation.
- Genuine leather sweatband, easily removed for sterilizing.
- Automatic friction joints. No turning or tightening.
- Jointed rear headgear for better fit and anchorage.
- Easy rear adjustment to head size.

Always insist on ® Trademarked Safety Products

American ® Optical
COMPANY
SAFETY PRODUCTS DIVISION
SOUTHBRIDGE, MASSACHUSETTS
Safety Service Centers in Principal Cities

YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU

NOW CONTROL BOTH

...with new J-M
Aluminized
Asbestos Cloth

An economical and easily worked combination of aluminum foil with asbestos fabric, J-M *Aluminized* Asbestos Cloth provides heat and flame resistance which exceeds that of either of the materials used alone.

The *aluminum* foil helps reflect 90% of all radiant heat—the major cause of worker discomfort, fatigue and inefficiency. The fireproof *asbestos* supplies flame-resistant sturdiness. In combination, the aluminized asbestos cloth retains great strength, even after long exposure to temperatures to 1400°F.

For data on J-M Aluminized Asbestos Cloth for curtains, shields, blankets, hoods, and other needs—write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

JM

JOHNS-MANVILLE

by **Chauncy Hart**
The Heil Co.

RUGGED dump truck weighs 27-tons; has 37½ cu yd capacity. Wheels on this giant are 5-ft high.

Giant aluminum dump truck bodies Mig welded

THE LARGEST ALUMINUM dump-truck bodies in the world roll off the production line at The Heil Co., Milwaukee—thanks to arc-cutting and welding equipment.

Built for the Aluminum Co. of America, the 27-ton trucks haul bauxite from Alcoa's mountain mines in the Dominican Republic to Caribbean ore boats. This sticky material, from which aluminum is taken, is quickly and easily removed by heating the dumper-floors with engine gases.

Each truck has a 37½ cu yd capacity and weighs 11,000 lb less than a similar steel truck. As a result, tire wear and gas consumption are reduced—and 11,000 lb can be added to the payload.

More than 5,000 ft of cutting and 20,000 ft of Mig welding go into each dump-truck, and since all welds are made in two or three passes, there are actually about 50,000 ft of welds in each.

The all-welded dump bodies are constructed entirely of Alcoa's high-tensile aluminum alloy 5454. Both plate and extruded sections are used in fabricating the unit, and although a majority of the components are ⅜-in. stock, many range up to 3-in. in thickness.

Mounted on a special Heil machine carriage and guided by a template, the arc-cutting torch slices the ⅜-in. plate at a rate of 60 ipm. Precision 90-deg cuts, made at 230 amp, 80 volt current setting, require no postcutting treatment.

The aluminum parts are then joined by automatic and manual Mig welding to form the various subassemblies making up the main body. A fully automatic Mig welder fabricates the body's side bolsters, consisting of two formed parts butt-welded in two passes.

Semiautomatic Mig welding is then used to join the bolster to the body side. All cutting and welding equipment used in the truck production is made by Linde Co.

SIDE bolsters are welded to the dump-bed in three passes using a Mig welding gun.

Some things are PRICELESS

To a drowning man nothing is more valuable than a life preserver. Every day, in thousands of shops, EUTECTIC "Low Temperature Welding Alloys"® are just such a "Life Saver".

In maintenance shops from coast-to-coast, and throughout the world, weldors have learned to rely on EUTECTIC products. They don't count the cost of these Priceless Alloys because they know what they will do. They know that every package carries a guarantee of satisfaction, of competent service from each of 300 qualified Technical Representatives. They depend on prompt delivery of factory-fresh products, from modern warehouses, in major centers throughout the country.

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You owe it to yourself to get all the facts on EUTECTIC low heat input welding that minimizes warping and distortion and produces joints that are often stronger than the original part. Fill out the handy coupon now and learn how you too can make tremendous savings through the use of the Priceless Hundred and Sixty EUTECTIC "Low Temperature Welding Alloys".

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MEN RESPONSIBLE FOR COSTS—men who must hold expenses in line and show a profit—have seven important reasons for preferring Ranite metallic-coated hardsurfacing rods:

1. Longer wearing parts—reduced downtime—increased production.

2. Repair costs reduced—Ranite-coated surfaces can be cut with oxy-acetylene torch when necessary for repair.

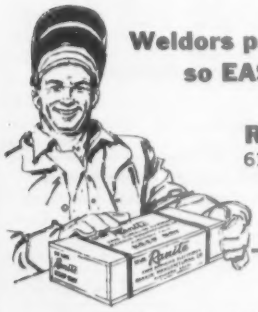
3. More than 80% recovery rate—no unnecessary flux in Ranite coating, maximum amount of coating enters the weld, no slag formed.

4. Rapid deposition rate—maximum metal deposited per man-hour. No splatter loss.

5. Minimum tendency to check—Ranite rods are alloyed with coefficient of expansion and contraction approximating that of parts to be hard-surfaced.

6. Deposits firmly bonded to base metal—Ranite can be applied to all steels, most cast irons and manganese steel *without* stainless bonder.

7. Smaller inventory needed—just five Ranite rods handle the great majority of all jobs. (Types A, BX, C, D and No. 4.)



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WELDORS' NO. 1 CHOICE FOR HARDSURFACING

Welded pipe to avert water shortage in India

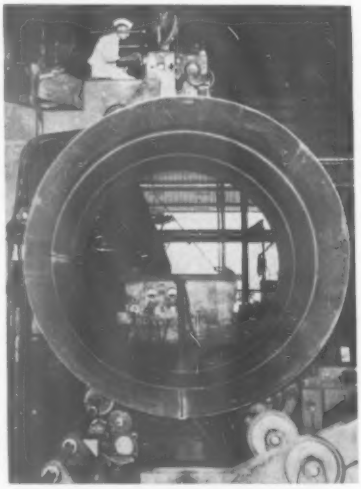
by **William A. Heath**

TANSA LAKE, from which Bombay, India, draws its water supply, was proving insufficient in its role of thirst-quencher for the city's 3,000,000 persons. To remedy this, the Indian government decided to boost the water supply by diverting River Vaitarna to the lake.

To make this diversion plan work, a 54-mile welded steel pipeline is being constructed. Over 47 miles of this giant water-main are 96-in. in diameter, six miles are 120 in. in diameter, and approximately ¾-mile is of 126-in. diameter pipe.

The line is being constructed of 36-ft units fabricated by Structural Engineering Works Ltd., in a specially built factory. Four automatic welders—two external and two boom type internal machines—are used. Each is driven by a 750 amp power pack.

Several operations are needed to fabricate the 36-ft sections from plate currently available in India. First, 25 and 30 by 6-ft mild steel plates, ⅜ and ½-in. thick, are rolled to form 6-ft lengths of pipe.



INDIAN weldor makes circumferential welds on three 6-ft lengths of pipe.

ARC welders fabricate ring girder supports for pipeline. Line is expected to be completed this fall.

The pipe is tack welded longitudinally, and three lengths then tack-welded to each other, and mounted on a roller bed. The resulting 18-ft pipe is then longitudinally welded, first externally then internally. Current settings vary from 28 to 30 volts.

Next, two 18-ft pieces are welded together, and the complete 36-ft section is rotated and circumferential welds made.

Production time required for fabricating pipe sections is kept to a minimum since all welding operations have similar requirements.

A continuous heavy-coated welding wire is used which gives deposits of low hydrogen, oxygen and nitrogen content. Wire 0.192 in. in diameter is used when welding $\frac{3}{8}$-in. plate, and 0.232 in. diameter wire is used on $\frac{1}{2}$-in. plate. Welding speeds are 12 ipm on $\frac{3}{8}$-in. plate and 15 ipm on thicker plate.

After a 36-ft section is completed it is pressure tested up to 260 psi, and the interior cleaned and coated with a red lead paint. The section is then moved via narrow-gage rail-track to the construction site. It is joined to existing pipe by manual metal arc welding using universal mild steel electrodes 0.192 and 0.160 in. in diameter.

A ring girder made of a 10 in. by 3 in. channel section is fillet welded to the pipe 9 ft from the end. This is to compensate for deformation stresses and give additional strength to the pipe so wall thickness can be kept to a minimum.

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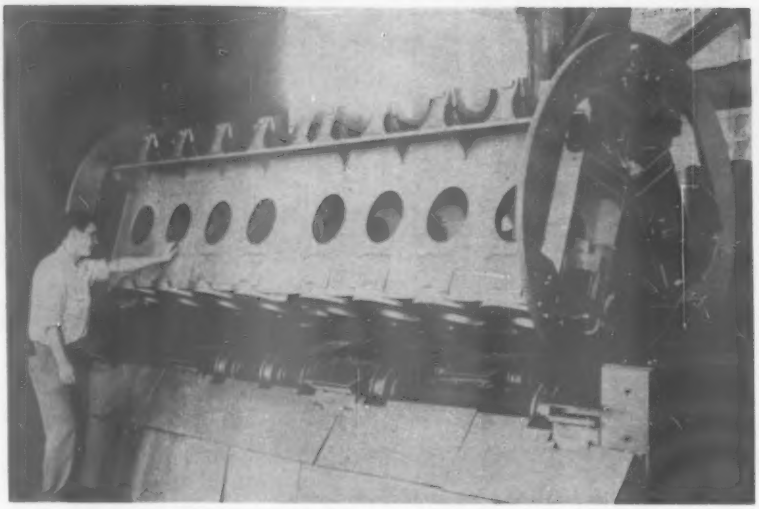

LARGE welded diesel engine crankcase section was blast-cleaned in only 32 minutes. Weldment is thoroughly cleaned internally and externally in a fraction of the time previously required.

Airless blast-cleaning can save you time and money

BETTER ADHERENCE for better appearance—this is a nutshell description of the advantages of airless abrasive blast cleaning.

In most cases, weldments in a product are painted, galvanized or otherwise coated for protection and/or sales appeal. However, weld spatter and flux, rust and other corrosion on these assemblies must first be removed so that coatings or paints will have proper adhesion.

Companies using airless blast-cleaning have realized more thorough and uniform cleaning, as well as time and labor savings.

An Ohio lift-truck manufacturer estimated a total annual savings of well over $40,000 after installing such equipment. Capable of handling work up to 108-in. long and 50-in. high, the Wheelabrator Corp. unit cleans more parts in one shift than were previously cleaned in two.

Savings on individual weldments ranged as high as $3.88 each and labor savings of 200 man-hours were recorded. One frame weldment, formerly requiring 105 minutes to clean, is now done in 35 minutes. Cleaning time on another weldment was reduced from 36 minutes to 12.

The mechanical nature of these blast-cleaning units easily lend themselves to modern materials-handling methods. Weldments are conveyed from the fabrication department; hoist-lifted to the work table mounted on the unit's open door; cleaned, and then conveyed to the paint shop.

A similar unit is used by a Pennsylvania manufacturer of shuttle cars, loaders and other mine equipment. Previous cleaning methods required as much as 360 man-hours per week. Airless blast-cleaning required only 30 man-hours, resulting in a labor savings of more than $400 weekly. Other manufacturers whose products range from galvanized ladders to spot welded details for aircraft pipe assemblies have reported similar time and labor cost savings.

All agree that the vexing problem of foreign material removal from weldments can be solved simply and economically through the use of airless abrasive blast-cleaning.

News shorts . . .

Susquehanna-Western Inc., Chicago, has contracted to purchase uranium ore from the Gas Hills properties of **Vitro Minerals Corp.,** New York City, for processing at the former's new mill at Riverton, Wyo. Total purchases under contract may exceed $15,000,000. . . Army researchers have determined that variation in electrochemical potential of crystalline metals can be controlled, and can yield valuable industrial and scientific information about structure and character of materials.

The new factory addition of **Dreis & Krump Mfg. Co.,** Chicago, is in operation. . . **Airline Welding & Engineering,** Hawthorne, Calif., has been awarded a $23,000 contract for welding positioners by **National Aeronautical Space Association Laboratories. . . Monsanto Chemical Co.'s Inorganic Chemicals Div.,** St. Louis, is building a plant to manufacture ultra-pure silicon metal.

Hotel Roosevelt in New York City will house the **Magnesium Association's** 15th Annual Convention on Oct. 19 and 20. . . **The Atomic Energy Commission** has awarded 22 contracts to develop new and improved industrial uses of radioisotopes and high level radiation. Among recipients of contracts are **Engelhard Industries,** Newark—a $50,000 contract to study industrial significance of radiation products and processes—and **Picker X-Ray Corp., Cleveland**—a $42,000 contract to demonstrate the feasibility of a self-powered X-ray tube.

Southern Oxygen Co., Hyattsville, Md., has placed in operation an electrolytic gas plant near St. Petersburg, Fla. The hydrogen production of the plant, in excess of 2,000,000 cu ft, will be used by General Electric Co., the oxygen will be distributed in Florida.

Industrial plants are now being given first-hand demonstrations of **A. O. Smith Corp.'s** CP-C-Omanual welding process. Salesmen are equipped with a self-contained trailer carrying all the equipment needed to perform on-the-spot CO_2 welding. . . **Welder's Supply Co.** has opened its 10th Southern California store. **Bob Van Dulm** manages it at 13343 Sherman Way in North Hollywood. . . **Foote Mineral Co.,** Philadelphia, will expand its electrolytic manganese facilities by the start of 1960. Production capacity will be upped 30%.

Air Reduction Sales Co. has opened a new branch in Cleveland. **Vince Horrigan** manages the branch, called **East Side Welding Supply. . . General Cable Corp.** has moved its headquarters to 730 Third Ave., New York City. . . **Ki-Weld Supply Co.** is Louisville's latest distributor, located at 1510 Mellwood Ave.

Alloy Casting Institute has moved from its Mineola offices to 1001 Franklin Ave., Garden City, New York. . . **Sylvania Electric Products Inc.,** New York City, is expanding production of molybdenum, tungsten and other refractory metals used in ultra-high temperature applications. The metals also find way into welding electrodes. Sylvania has set up a new firm to market closed-circuit television-cameras and related equipment—**Sylvania Electro-Specialties.**

Lenz Co., manufacturer of steel tube, pipe and hose fitting products, has more than doubled its plant capacity by expanding its Dayton facility. . . **Westinghouse Electric Corp.** will spend more than $25,000,000 to expand and modernize facilities for the manufacture of turbines, generators, large motors, etc., at plants in Lester, Pa., East Pittsburgh, and Sunnyvale, Calif. Specially designed automatic arc welding equipment will be installed.

Resurfacing wire

Line of tubular wire for semiautomatic resurfacing is for use with any semiautomatic welding unit. New wires and their physical characteristics are: HB-94, resistance to abrasion, impact and oxidation; HB-94, excellent abrasion resistance when cold; HB-4560, for heavy-duty build-up; and HB Nimang, for build-up and joining Manganese steel parts. The 7/64-in. wire is furnished in coils of 12-in. ID by 3-in. wide which weigh about 50 lb. *Hobart Bros. Co.*

Circle No. 1

Cutting tips

New line of cutting tips for use with natural gas and propane are all of hard, three-seated type with improved preheat patterns. Designated Style 260 straight bore and Style 360 divergent hi-speed, these new tips are designed for use with standard Airco 3000 and 9000 hand cutting torches; 3700 and 3800 hand cutting attachments; and 4700 machine cutting torches. No additional accessories are necessary. *Air Reduction Sales Co.*

Circle No. 2

Automatic pipe welder

Automatic pipe welding machine produces sound welds with full penetration without back-up rings. Pass on 4-in. pipe takes 11 seconds; machine handles pipe with OD of from 4 to 11-in. Electronic tubes, frequently the cause of trouble in automatic units, are replaced by magnetic amplifiers and semiconductors. All electrical controls are housed in vapor-proof cabinets. A finely regulated motor permits good speed control of head rotation. *Aluminum Co. of America*

Circle No. 3

HI-AMP

ELECTRODE HOLDERS

CABLE ATTACHMENTS

GROUND CLAMPS

Offers

T.P.C.*

* THREADED POWER CONNECTION

Excessive heat in a welding circuit is oftentimes caused by a resistance build-up at some point in the welding circuit due to connections being loose or oxidization setting up in a mechanical type of terminal connection.

Shown in the above "cut-a-way" picture of an Electrode Holder is the new HI-AMP, T.P.C. type of connection that can be adapted to ground clamps and quick disconnect plugs as well as to electrode holders.

T.P.C. means a Threaded Power connection using the pressure of threads on a sleeve to drive the ends of any welding cable down into the depth of a cable socket, then locked into place with threaded plugs. An excellent electrical connection as well as providing direct contact with the welding cable to the accessory so that maximum heat is conducted into the heat-absorbing cable.

ASK YOUR WELDING SUPPLY HOUSE FOR FURTHER INFORMATION

354 W. ADAMS ST. LENCO, INC. JACKSON, MO.

Centerless grinder

Grinding action in new centerless grinder is improved by straddle bearings which provide support on both sides of wheel to prevent normal deflection. Grinding wheel slide allows precise wheel feed on plunge grinding operations, while wheel feeding is adjusted by a handwheel index graduated to fifty-millionths of an inch. Regulating wheel grinding speeds are adjustable from 8 to 66. *Norton Co.*

Circle No. 4

Rotary actuator

SM-18 is a high torque, rotary actuator for remote and automatic control of industrial equipment. Governed by a precision potentiometer, gear connected to the output shaft through a wide range of ratios, the full scale control ranges from 1/6 to 40 shaft revolutions. SM-18 is available in single and three-phase cycles with ratings to ¾ hp, or 500 watt units offered in two phase, servotypes. *The Jordan Co.*

Circle No. 5

Aluminum back-up bar

Back-up bar of machineable aluminum alloy with replaceable T-shaped insert is used in inert gas-arc welding of aluminum. Among advantages claimed for bar are aluminum's quick dissipation of welding heat (and therefore less weldment distortion) and the stainless steel insert's low cost, so that they may be discarded when grooves are burned and pitted. *Reynolds Metals Co.*

Circle No. 6

Steel lifting clamps

Light weight, compactness and wide jaw opening capacity are features of Bulldog line of steel lifting clamps. These no safety-lock clamps have advanced features over previous non-locking and semi-locking clamps. They are available in ½ ton, 1 ton, 4 and 7 ton sizes. *J. C. Renfroe and Sons, Inc.*

Circle No. 7

OPERATION
WELDING:
at Space Station #1
Located 1,075 miles above the earth and traveling 15,840 miles per hour in surroundings where there is no atmosphere or weight, where the sun's rays may heat an object to 4,000°F., and where hazards like cosmic radiation are ever-present, will be Space Station #1 — the construction site for the first moonships.
Can existing welding methods be employed on these moonships under such environmental conditions? What special welding equipment will be needed? In preparation for man's first trip to the moon, RACO engineers are researching these and other critical space age questions. For forty years, RACO has touched on the borders of tomorrow, anticipating and meeting the diverse welding needs of industry.
RACO utilizes the most advanced automation techniques to produce all grades of precision welding wire drawn to rigid metallurgical specifications, and a complete range of welding electrodes engineered to fulfill all requirements with complete reliability.
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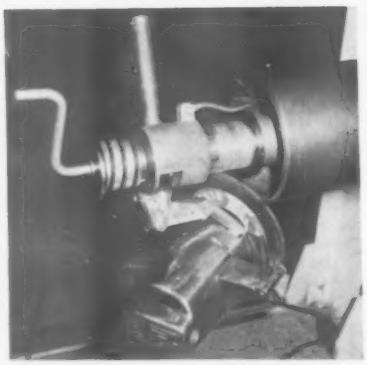

Electric grinder

New electric powered grinding machine cleans, cuts and puts lands on bevels automatically. The Bevel-Land grinder is said to be the first automatic equipment ever developed for this work. It replaces hand tools and grinders, while providing uniformity on all jobs. Unit comes in two models—one fits pipe 6 to 14 in. and the other handles 14 to 36 in. pipe. Light weight, portable machine can be locked in place inside pipe in seconds, and a simple adjustment in the angle of the grinding wheel is all that is required to change machine from a cleaning to a land position. *H & M Pipe Beveling Machine Co.*

Circle No. 9

Electric motors

New NEMA rated line of dripproof electric motors is available in sizes from ½ hp at 900 rpm through 150 hp at 3,600 rpm, frames 182 through 445 URS. Die cast aluminum rotors have dual cooling fans and the entire assembly is dynamically balanced. These motors are available either 2 or 3 phase and in all frequencies and commercial voltages below 600 v. *The Lima Electric Motor Co.*

Circle No. 10

Welding apparel

Garments for use with gas-shielded electric welding are made of brown, soft-grain leather which is light, flexible and offers protection from harmful heat rays. The line includes a short jacket, a 26-in. jacket, sleeves, cape sleeves and cape sleeve and bib. *American Optical Co.*

Circle No. 11

1,580-ton expander

Hydraulic expander can size or straighten pieces with internal diameters from 36 to 74-in. and in lengths of up to 16 ft. Notable features include drawbar pull of 1,580 tons, electro-hydraulic-mechanical jaw diameter setting and measuring device permitting complete control at central console, and the capability of handling parts having an extreme length-to-diameter ratio. *Grotnes Machine Works, Inc.*

Circle No. 12

Metal spray powder

Colmonoy C-290, an easily-applied, long-wearing metal spray powder, is designed for rebuilding worn engine and compressor crankshafts. Applied with Colmonoy Spray-welder unit, C-290 is high in chromium and nickel, and contains wear resistant chromium borides. After application, metal spray overlay is finish ground. *Wall Colmonoy Corp.*

Circle No. 13

Safety gloves

Four new safety glove styles have been added to industrial glove line. Type E-GR is of chrome-tanned, green cowhide for protection of hand, wrist and lower arm. D-SS is an economical light work, light welding glove. Style AR-1, a heat resistant weldor's mitten and GR-SS, a driver-style glove for miscellaneous work where light protection is required, are also available. *Air Reduction Sales Co.*

Circle No. 14

Induction heater

Induction unit for silver soldering of motor rotors is especially adaptable to manufacture of subfractional horsepower motors. A sliding and indexing jig makes possible the manufacture of up to eight rotors per minute by one operator on this semiautomatic operation. Equipment consists of a 7½ kw output induction generator with special heating coils for various diameter rotors. *Reeve Electronics, Inc.*

Circle No. 15

FOR ANY STAINLESS WELDING JOB

Drawalloy
CORPORATION

Stainless Steel Welding Wire

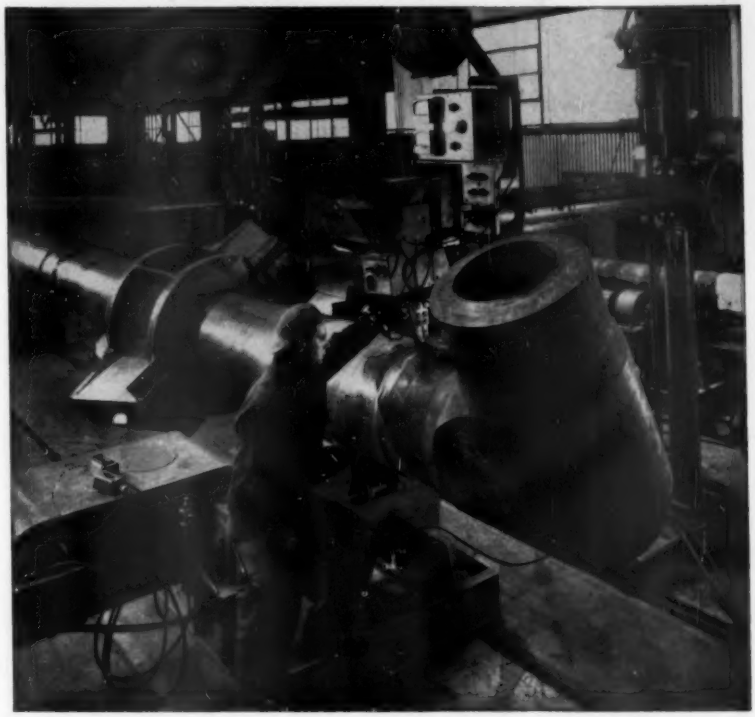

Photo courtesy of National Valve and Manufacturing Co., Pittsburgh, Pa.

Specify Drawalloy "quality controlled" stainless steel welding wire for *your* next "quality weldments." Your greatest advantage is experience . . . our experience in producing wires for welding exclusively. Because we are specialists, Drawalloy stainless steel welding wire is produced to strictly controlled specifications to provide the right chemistry, finish and temper for the finest quality weld metal and smoother operation in your automatic or semi-automatic equipment. Drawalloy stainless wires are available in all popular grades as well as 2¼ Cr, 1 Mo; 1¼ Cr, ½ Mo.

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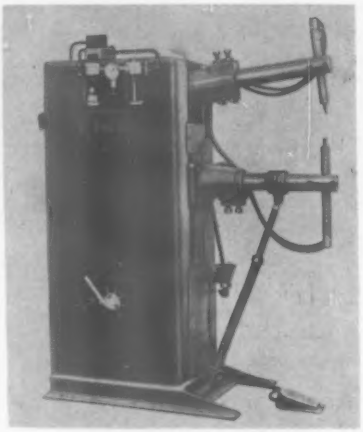

Rocker-arm spot welder

Single phase rocker-arm spot welders have nylon trunion bushings that never require oiling and contact switches that need no adjustment regardless of set-up changes. Available in either air-actuated and foot operated models, the new welders have KVA ratings of from 10 to 75, throat depths of 12 to 36 in. Sequence timing and heat adjustments provide high-speed welding of all types of weldable metals. *Universal Electroweld Div.*

Circle No. 16

Current interrupter

New secondary contactor can be used with any d-c welding power source to interrupt high amperage current. Unit is intended as auxiliary equipment for Mig and Tig applications, where power source used does not have a primary contactor. Rated at 600 amp, it operates on 115 volts, single phase, 50 or 60 cycles. *Air Reduction Sales Co.*

Circle No. 17

Plate jigs

Simple plate jigs can now be made by assembling four jig legs in a plate. Larger bearing surface at leg top means longer accuracy; large rest button on tops provide adequate clearance to protect drill jig bushings and offer more bearing surface for spot facing on opposite side. Both leg ends and rest buttons are hardened for longer wear. *Jergens Tool Specialty Co.*

Circle No. 18

Transfer system

Over and under transfer system improves efficiency of automatic transfer machines and automated welding machines. Utilizing a cam-index drive which provides high speed, shock-free indexing, the system moves a series of pivot-connected pallets in a closed loop. Over and under units are of modular design for easy and economical station addition or removal. *Expert Welding Machine Co.*

Circle No. 19

Portable punch press

Fifteen-pound portable electric punch press produces any shape hole. Porta-Press is designed for use on all materials to ⅛ in., welded or laminated sheets up to the same thickness. Hole shape and size is dependent on easily-changeable punch and die. *Modern Mfg. Co., Inc.*

Circle No. 20

High-frequency heaters

High-frequency heating is performed in two small vacuum-type units. For heating metals, Model L4C Induction generator develops ½ kw. Model C-63 dielectric generator also has an output of ½ kw for heating non-conductors such as plastics. Both machines are available with full control over power output and time cycles, and operate from 110 volt a-c lines. *Reeve Electronics, Inc.*

Circle No. 21

Aluminum filler wire

Type A5556 is new addition to aluminum filler wire line for use with Mig and Tig processes. Designed to weld high tensile aluminum alloys such as 5083, 5086 and 5456, the wire can be used in all types of aluminum fabrication where post heat treatment is not feasible. This magnesium-aluminum wire is available in Type "A" finish. *Air Reduction Sales Co.*

Circle No. 22

Ground rod connection

One Shot mold, a ceramic disposable unit replacing semipermanent graphite mold, is now available in several cable and ground rod sizes. Producing a permanent connection with 100% current carrying capacity of the conductors, One Shot cannot loosen or corrode. *Erico Products Inc.*

Circle No. 23

ELECTRIC-ARC INC.

One of a Series on Applications of Electric Arc's Smith-Dolan Units — Today's Most Versatile Heat-Treating Tools.

STOP WELD FAILURE
with the
SMITH-DOLAN SYSTEM
of Low-Frequency Induction Heating

Here is the versatile heat-treating tool you need for producing sound welds easily and economically in carbo-alloy and other types of steel pipe . . . here is precision control of heating cycle when pre-heating and stress relieving — uniform, through-and-through heating of solid sections up to two feet thick and more — pushbutton operation — complete portability for on-the-job heat treating anywhere.

Many Money-Saving Applications — The Smith-Dolan System simplifies and upgrades work quality in numerous applications ranging from welding to forming and annealing. Units are available for 60 cycle heating in capacities ranging from 10 to 150 KVA . . . for 400 cycle heating . . . resistance heating. Pre-engineered with complete instrumentation, accessories.

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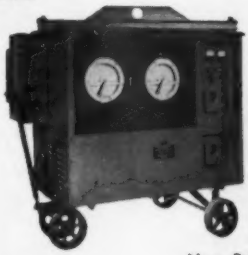

Electronic recording gives permanent charts of heat run on this standard Smith-Dolan model. Coils permit work at 50 feet or more from unit. Eye hooks provide for easy handling by crane. Products ranging from a fraction of an inch to 10 feet in diameter can be heat treated on the job.

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Impact tester

Power operated impact tester performs Izod, Charpy and Tension-Impact tests for metals. Safety features include electric safety-clutch brake, motorized pendulum return and remote controls. Because the remote controls may be safely located, impact tester is adaptable to testing materials which might shatter or those which are radio-active. *Testing Machines Inc.*

Circle No. 29

Epoxy laminating resin

Epocast 28, in conjunction with Hardener 9012, displays good thermal stability and uniform dielectric properties over broad range of temperatures when used for glass fiber lamination. Also suited to potting and encapsulating electric components, Epocast 28-9012 has a relatively short cure at moderate temperatures. *Furane Plastics Inc.*

Circle No. 30

40 volt arc welder

M-295 welder is 40 V, 60% duty cycle machine which fills gap between very small and very large welders. Welder features current setting through a moveable shunt; two ranges of from 25 to 115 and 80 to 295 amp; Cam-Lok connectors; and a 25¼-in. high backed enamel case. Wired for either 230 or 460 V, the M-295 is also available with power factor correction, special voltages and complete accessory package including skids and running gear. *Miller Electric Mfg. Co.*

Circle No. 31

Industrial stethoscope

Industrial stethoscope diagnoses faults in machines and pipe lines, and tests pressure-tight packages. Able to detect knocks, taps and leaks, this low-cost stethoscope is finding almost endless uses in industry, says manufacturer. *Edmund Scientific Co.*

Circle No. 32

Oil-burning salamander

Oil-burning salamander has longer life and improved operating efficiency, says manufacturer. Improvements include alloyed cast iron elbow, heavier diffusion hood, and two piece stack. Positive lock-down handles are safety feature. *Nugent Corp.*

Circle No. 33

Bronze welding rods

Designated Airco-20 (bronze), Airco-22 (manganese bronze), and Airco-27 (low-fuming bronze), these high speed production rods are suitable for work where only a small amount of flux is needed to prepare and clean the weld, and where removal time of flux residue is at a premium. Thin extruded flux coating is odor free, smooth, concentric, will not flake under normal conditions, and has excellent cleansing action, it is claimed. The rods come in 3/32, ⅛, 3/16, and ¼-in. diameters. *Air Reduction Sales Co.*

Circle No. 24

Tig torch

One-hundred amp Tig torch is made of materials able to withstand intermittant heat of 6,000 F., and continuous heat of 3,200 F. The chuck will hold electrodes in sizes from .020-in. to .062-in. Also available is a 300 amp water-cooled model which will take 50% variations in electrode diameter. *The Weldma Co.*

Circle No. 25

Air-hydraulic cylinder

Combination air-powered hydraulically controlled cylinder gives improved feed over simple air cylinder. Numerous combinations of rapid transverse and feed throughout the stroke can be set up, says manufacturer. The Air-Hydraulic unit is made in 2 and 3-in. bores, with 2, 4, 6 and 8-in. stroke lengths. The 2-in. units give thrust about three times air line pressure; 3-in., seven times line pressure. *The Electro-Mechano Co.*

Circle No. 26

Safety glasses

Metal frame safety glasses with choice of six types of side shields combine better eye protection with smart appearance. The model combines a metal frame with Bal-Safe lenses, with an expansion-type endpiece which allows easy assembly of both lenses and side shields. Shields include wire mesh screen, heat-resistant wire mesh, and four designs in clear or green acetate. *Bausch & Lomb Optical Co.*

Circle No. 27

Ring-type film badge

Ring-type film badge is now available to all subscribers of Tracerlab Twin Film Service. Since the hands often receive more radiation exposure than the rest of the body, the badge is made of an elasticized cloth ring that will fit all fingers. The film packet is sealed in a thin transparent plastic which protects it against moisture. *Tracerlab Inc.*

Circle No. 28

ATLANTIC WHEELS

float through the roughest jobs . . .

Even on the toughest flash and weld removal operations, you can depend on Atlantic Grinding Wheels for fast, cool, clean-cutting action. Made with a special resinoid bond to withstand high centrifugal forces and assure maximum safety, they have a smooth, floating action that calls for less pressure on the grinding surface . . . helps reduce operator fatigue and increase efficiency.

If you have any type of metal removal or smoothing problem, it will pay you to give Atlantic Grinding Wheels a trial run. An Atlantic representative will be glad to recommend the right wheel for your specific requirements. Write for details and a copy of the Atlantic Grinding Wheel Catalog. Atlantic Abrasive Corp., 540 Pearl Street, So. Braintree, Mass.

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Water-cooled Tig holder

This water-cooled, 350-amp, manual Tig holder is as small as most conventional 200-amp holders. Handles tungsten electrodes 0.020 through 5/32-in. diameter, in lengths from 2 through 7 in. The H35-B can be used with argon, helium or mixtures of these gases. In confined spaces, this holder has a minimum of 2⅞-in. interference dimension when using a 2-in. collet cap assembly and short nozzles. *Air Reduction Sales Co.*

Circle No. 34

Vinyl-jacket welding cable

Copper welding cable has vinyl-jacket completely resistant to corona and ozone cracking. Made of electrolytically pure copper, the HVF cable is flexible and has a long flex-life without insulation slipping back, says manufacturer. Vinyl jacket also offers resistance to effects of abrasion, grease, oil, moisture and impact. *Belden Mfg. Co.*

Circle No. 35

Oxygen therapy regulator

Oxygen therapy regulator designed for use with any bubble-type humidifier is suited for emergency administration of oxygen. Extra-long inlet allows for easy attachment to oxygen cylinder, and spring-loaded safety relief valve opens at high pressures, reseating itself when pressure drops to normal. Gages have a diameter of 2-in. *Smith Welding Equipment Corp.*

Circle No. 36

Chemical milling coating

Light-sensitive, etch-resisting plastic coating material is used in chemical milling method of removing wide range of metals. Light-sensitive, the areas "masked" from high-intensity illumination resist all commonly used acids, alkalis and electrolytes. Atmospheric changes do not affect exposure time, and material has long shelf life. *Eastman Kodak Co.*

Circle No. 37

Work glove

"Python" is a flannel-lined, neoprene coated work glove, designed for the safe handling of slippery, chemically corrosive materials. The neoprene latex of the glove surface is rough finished for sure gripping. *The Granet Corp.*

Circle No. 38

About people . . .

Wilson

Willis

Miller

Clipsham

The board of directors of the Lincoln Electric Co., Cleveland, recently elected three new vice presidents and a secretary. *R. A. Wilson, G. F. Willis* and *E. M. Miller* hold the former positions, with *George F. Clipsham* being secretary.

James J. Gibbons has been named director of marketing for A. O. Smith International, S. A. He will headquarter in Milwaukee. At the same time, *Sidney McNiece*, former manager of the Caracas, Venezuela, office has been transferred to Milwaukee to serve as assistant to the president. Also, *Edward A. Lukowski* has been named group merchandising manager for the A. O. Smith Corp.

O. M. Donohue has been moved to administrative assistant, eastern region, Air Reduction Sales Co., at Union, N. J. His former position as district manager of the metropolitan district located in Jersey City, N. J., has been filled by *C. D. L. Perkins*.

E. E. (Gene) Brest has been appointed general superintendent of all Pacific Coast plants by the Air Reduction Pacific Co. He replaces the deceased *Frank Myers*.

The Canadian Welding Bureau has recently appointed *Joseph T. Biskup* chief welding engineer. He will headquarter at Bureau offices in Toronto.

MODERN, STRATEGIC DEFENSE PLANNING . . .
WELSH WELDERS' FLASH SPECTACLES!

Protects against impact, light or flash hazards where a completely enclosed, cup type, safety goggle is not required.

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Sturdy, precision-made, metal frame spectacles with solid plastic or leather side shields.

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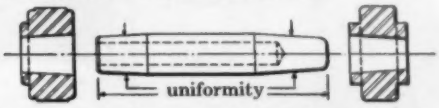
TUFFALOY

They Look different... and they Are!

The bright and shiny look of the new Tuffaloy spotwelding tips is due to a process that practically eliminates oxidation. More than that, it reflects the deep-down quality built into these tips and into all Tuffaloy products.

What you want in these tips is highest conductivity and resistance to deformation. Tuffaloy provides this by the most modern manufacturing methods, and by constant scientific quality control all the way: alloying of pure copper, semi-continuous billet casting, bar extrusion and salt bath heat treating.



And in converting this high-quality bar stock to welding tips, Tuffaloy insures conformity to all standard dimensions. Before shipment all tips must pass inspection by gage for uniformity in length, Morse taper, and the outline of the point.

Tuffaloy resistance welding alloy products are widely available through Airco and Tuffaloy representatives. Call on them for SPOTWELDING TIPS (Standard, 'Tuffcap', Cold-Bent, and Special), Holders and Adapters, BAR STOCK, FORGINGS, SEAM WELDING WHEELS, and all other welding alloy needs. Ask for Catalog and Price List.

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Send for booklet and chart on all types and forms of aluminum in BRIGHT FINISH... including 1 lb. and 10 lb. spools. Company branches at St. Louis, South Gate, Calif., and Toronto afford ready supplies and service.

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Jones

Roediger

Wendell Jones was appointed district representative for Tennessee, Alabama, Mississippi and Louisiana by Hobart Bros. Co., Troy, Ohio. He succeeds *Robert E. Roediger*, who is now manager of electrode sales.

Amperex Electronic Corp., Hicksville, L. I., N. Y., has established two new executive positions, both filled from within the organization. *John Messerschmitt* is manager of Power Tubes and Renewal Sales; *Irwin Rudich* is manager of Special Tubes and Semiconductors.

Four new salesmen have been added by Emerson Electric Mfg. Co., St. Louis. *Richard C. Mundwiller* will handle welder sales in the northwest; *Sam N. Garber* will work in the western states; *Harold F. Flynn* will work in the east, and *H. Kroh* will introduce welders in Hawaii.

New officers have been nominated for the American Society of Metals, and will be formally elected at the annual meeting of the Society, Nov. 4, in Chicago. *Walter Crafts*, Union Carbide Metals Co., Niagara Falls, N. Y., has been nominated for president; *William A. Pennington*, University of Maryland, College Park, nominated for vice president; and *Robert J. Raudebaugh*, International Nickel Co., New York City, for treasurer. Two men were nominated for trustees—*A. H. Fairchild*, Western Electric Co., Winston-Salem, N. C., and *C. H. Samans*, Standard Oil Co., Whiting, Ind.

New director of advertising and publicity, Metal & Thermit Corp., New York City, is *E. S. Nuspliger, Jr.* He was a vice president at G. M. Basford Co.

John D. Clark has been named sales manager, eastern region, and *Douglass S. Collins*, sales manager, southern region, by the Foote Mineral Co., Philadelphia. At the same time, *Dr. D. W. Mitchell* was appointed coordinator, research and production, for the company.

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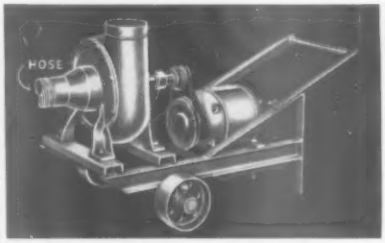
RUEMELIN *Portable* Fume Collector

Removes gas, smoke and heat from welding operations. Recommended for ventilation of tank interiors, manholes, vats, airplane fuselages or for blowing fresh air into inaccessible places.



• Collector is equipped with a power unit capable of handling up to 35 ft. of steel tubing. Mounted on rubber tired wheels for ease of handling. Models also available mounted on steel legs for hose operation in a complete 360 degree circle.

• This view shows inlet hood picking up welding smoke. Operator breathing zone protected.

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Fraser

Dato

Donn Fraser is the new field representative in Canada for Arcair Co., eastern division, Lancaster, Ohio.

Linde Co., New York City, has named *J. E. Dato* sales manager, electric welding. He was formerly manager of electric welding in the east.

Fred Jaeger is manager of the recently formed safety department at Essex Welding Equipment Co., Newark, N. J. He was formerly with Mine Safety Appliances.

Three new officers were recently elected by The Welded Ring Manufacturers' Association at Pittsburgh. *A. S. Martin,* president of King Fifth Wheel Co., Wilkes-Barre, Pa.., was elected president. *F. J. Fabian,* general manager of Dresser Mfg. Div., Bradford, Pa., was made vice president; and *W. J. Sampson, Jr.,* president of The American Welding & Mfg. Co., Warren, Ohio, was elected treasurer.

Sperry Products Inc., Danbury, Conn., has established four new sales districts headed by the following managers: *Tracy W. McFarlan,* eastern district, New York City; *Ralph H. Frank,* central district, Pittsburgh; *James M. Dickey,* midwest district; and *Carl B. Haugh,* western district, Los Angeles.

Edwin F. Hoad has been promoted to marketing supervisor for coated abrasives and new products, Minnesota Mining & Manufacturing Co., St. Paul.

Dr. Benjamin R. Teare, Jr. is president-elect, for the year 1959-60, of the American Society for Engineering Education. Dr. Teare is Dean of the College of Engineering and Science, Carnegie Institute of Technology.

William Morris has been added to the engineering staff of Balteau Electric Corp., Stamford, Conn.

THERMO is FIRST Again with a Revolutionary Sta-Kleen All-Plastic Cover Lens

Never Before Available for Use in Welder's Helmets

40% MORE LIFE

LABORATORY TESTS PROVE WHY . . . .

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WELDER MFG. CO.
MILWAUKEE

WELDING ENGINEERS

MACHINERY BUILDERS

ESTABLISHED
1936

William C. Russell has joined the sales department of Fibre-Metal Pacific, Inc., Bell Gardens, Calif. He will cover Southern California, Arizona and Nevada.

Richard S. Halladay and *Robert P. Smith* are sales engineers, Nuclear Systems, a division of Budd Co., Philadelphia. Both will headquarter in Chicago.

A recent addition to the staff of Arcos Corp., Philadelphia, *Walter H. Wooding*, has been honored by the Drexel Evening College Alumni Association for "outstanding performance in the field of engineering." Wooding has been honored before for his work with welding and its advancement.

Merritt L. Smith, formerly director of advertising and publicity, Metal & Thermit Corp., New York City, has now established an advertising and public relations office at 750 Third Ave.

Wilton Tool Mfg. Co., Inc., Schiller Park, Ill., has made two new executive appointments. *Alex J. Vogl*, formerly general manager, is now president of the company. *William Ferrick*, who was sales manager, is now vice president-sales manager.

George A. Medsker has joined Gasflux Co., Elyria, Ohio, as vice president and sales manager. He was with Nelson Stud Welding Co., Div. of Gregory Industries.

H. K. Miller Inc., Chicago, has named *Jim Aspel* sales engineer for its western suburban territory. *Ed Goddard* is sales engineer for hardfacing and build-up sales.

Died . . .

John Mulder, a member of the board of directors of Miller Electric Mfg. Co., Inc., Appleton, Wis., died August 2. He joined the company in 1929, and retired from his position as secretary shortly before his death.

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LIQUID OXYGEN
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Vertical Models—300, 600, 1200 gal.
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Storage and transport containers for liquid oxygen, nitrogen and argon from 50 to 2,500 gal. capacities

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Light in weight, yet sturdy and rust-proof. Assembles in 5 minutes — no threads. Folds flat. Dozens of uses — welding curtain, machine screen, grinding shield, wall curtain, etc. Available in all sizes. Ask your dealer or write us.

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These and other advantages give you better protection, comfort and ECONOMY.

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DRILL KIT

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Ferrous metals

ASTM STANDARDS, PART I. FERROUS METALS SPECIFICATIONS. Published by American Society for Testing Materials, Philadelphia, 1959. Cloth, 6 by 9 in., 1,620 pages. Price, $12.00.

Part I of the 1958 ASTM Standards covers federal ferrous metal specifications and includes 291 standards.

These standards are for carbon and alloy steels including: structural, rivet boiler and pressure vessel steels; steel plates; concrete reinforcing and commercial bar steel; hot and cold finished bars; spring and spring wire; billets, forgings, booms, axles, wheels and tires; castings, chains, bearings, boltings and pipe fittings; pipe and tubing; zinc and lead coated steel particles; wrought, cast and malleable iron; ferrous alloys and metal powder products, welding electrodes and rods.

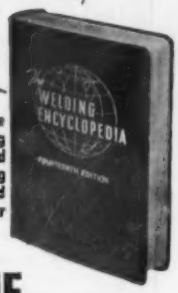
Of particular interest are the various steel specifications, especially those dealing with welded steel products. Also of interest is a section dealing with welding electrodes and rods. It gives complete data on the eight specifications covered; mild steel, arc welding electrodes, iron and steel gas welding rods, corrosion resisting chromium and chrome-nickel steel covered welding electrodes, low alloy steel covered electrodes, corrosion resisting chromium and chrome-nickel steel welding rods and covered electrodes for cast iron, surfacing welding rods and electrodes, and tungsten arc welding electrodes.

Non-ferrous metals

ASTM STANDARDS 1958, PART II. NON-FERROUS METALS SPECIFICATIONS, ELECTRONIC MATERIALS. Published by American Society for Testing Materials, Philadelphia, 1959. Cloth, 6 by 9 in., 1,380 pages. Price, $10.00.

Non-ferrous metals specifications and electronic materials included in Part II of the 1958 book covers 251 standards for aluminum, magnesium, copper, lead, nickel and their alloys; lead and tin base alloys; titanium, zinc and various materials for elec-

NOW—find the answers to your **WELDING PROBLEMS** *faster!*



Here, complete in one volume, are all welding fundamentals and practical working techniques—arranged alphabetically for speedy reference.

THE WELDING ENCYCLOPEDIA

Edited by T. B. Jefferson, Editor and Publisher, *Welding Engineer*. 13th Ed., 1008 pp., over 1400 illus., $7.50.

The working guide for all welding applications in all industries is a must for engineers, designers, supervisors, foremen, and weldors. Over 2000 subjects—in alphabetical order and cross reference throughout—put the facts you want at your fingertips. It covers all phases of welding, cutting, flame treating, etc., as well as problems of production, repair, and maintenance. Handy tables and charts . . . dictionary of trade names . . . buyers' manual—all go to make this a vital guide wherever welding is used.

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arc welding
gas welding
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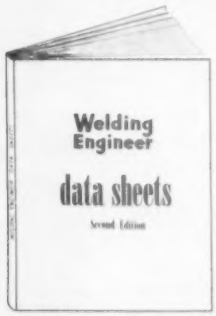

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Test methods

ASTM STANDARDS 1958, PART III. METAL TEST METHODS (EXCEPT CHEMICAL ANALYSIS). Published by American Society for Testing Materials, Philadelphia. 1959. Cloth, 6 by 9 in., 992 pages. Price, $10.00.

In the third part of the 1958 book of ASTM Standards the methods of testing metals are covered in 121 standards. Everything except chemical analysis is included.

Discussed are such subjects as metalography, mechanical testing, the effects of temperature on the properties of metal, corrosion and surface coating test, test for electrical and magnetic properties, non-destructive tests, save analysis and particle size measurement, condensity, sampling methods and miscellaneous methods of test.

Recommendations, definitions and methods of non-destructive testing cover nearly 150 pages of the volume. There are, of course, descriptions of how to conduct bend tests, tensile, compression and hardness tests, all frequently required in welding operations.

Plastic design analysis

PLASTIC DESIGN OF STEEL FRAMES. By Lynn S. Beedle. Published by John Wiley and Sons Inc., New York. 1958. Cloth, 6 by 9 in., 406 pages. Price $13.

This book presents the basic principles and methods of plastic design and shows how they may be used in the solution of practical building frame design problems.

The first six chapters of the book present fundamental concepts and the methods of analysis and design. Numerous examples are included, and problems are provided for the student. The last three chapters are concerned specifically with design.

This is an important textbook, not only for the structural engineer, but for the welding engineer, for without welding, plastic design would be impractical.

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plastic theory in the methods of plastic analysis, Dr. Beedle covers such secondary design considerations as the influence of sheer force, axle force and buckling. His review of theories leads to a convenient design check, which makes sure that some secondary factor does not prevent the structure from meeting the original design objective.

In a chapter on connections, the author suggests a design procedure based on the plastic method of analysis for proportioning building connections. Attention is focused on welded connections with some comments made on bolted and riveted joints.

Another highlight is a chapter on design guide. It is a summary of all the general provisions, analysis procedure, design procedure, and secondary design guides presented in the book.

Plant construction

INDUSTRIAL BUILDING DETAILS, 2nd edition. By Duane F. Roycraft. Published by F. W. Dodge Corp., New York City, 1959. Cloth 8½ by 11 in., 352 pages. Price, $12.75.

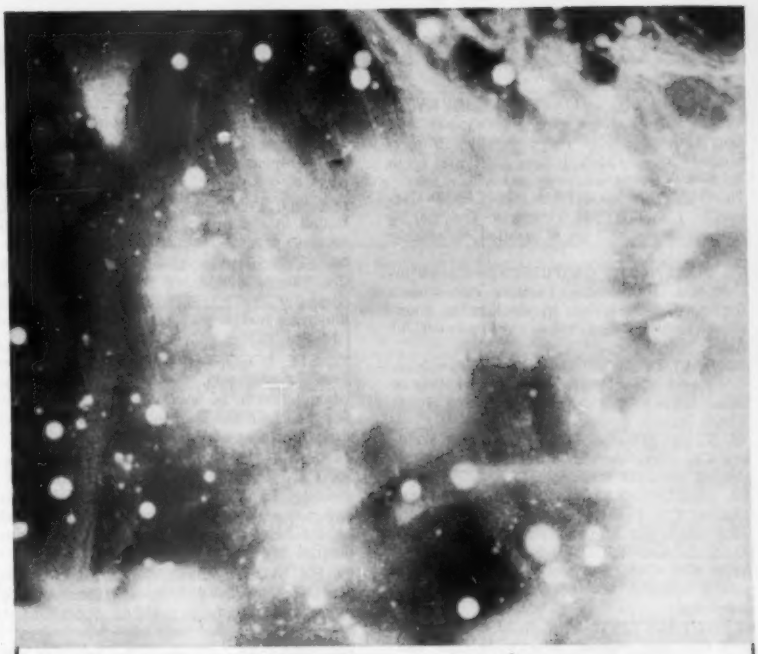
Industrial Building Details is a well illustrated book, with its 1,500 drawings showing every detail of the contemporary industrial building.

Details required for structural steel walls, windows, louvres, roofs, storage and transport facilities, stairs, landings, catch basins, and every other facet of construction are given. The drawings are sharp, legible, clearly labeled and explained, and large enough to be traced or projected.

The many details given make the book a valuable reference to engineers, designers and industrial building contractors, etc. Welding details are extensively covered, though they could be treated more thoroughly in the structural details portion of the volume.

Dozer blue-prints, others, offered through catalog

A catalog offered by Robertson's Tried and True Prints contains drawings of dozers, rock guards, canopy tops, etc., that are available from the company in scale drawing and blueprint form. Booklet costs $1, but money will be returned with first order of $5, or more. For information write 1152 Pioneer St., Enumclaw, Wash.



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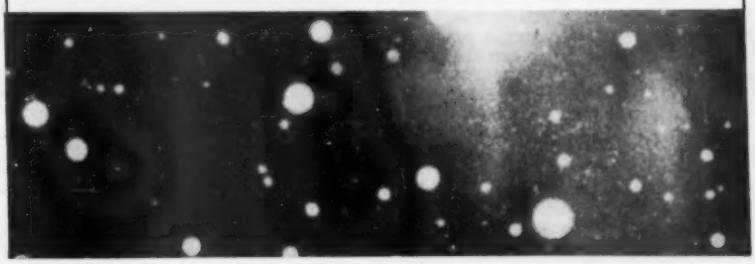

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75. INSPECTION UNIT — Curtiss-Wright Corp. Specifications, special features and operating principles for company's Immerscope Model 424-A testing unit are given on flyer.

76. OXYGEN CONTAINER—Liquid Carbonic. Liquidox 3M container for storing oxygen in liquid form is detailed on catalog sheet.

77. PORTABLE GRINDERS — Carborundum Co. Built-in-guard safety cup wheels for portable grinding in steel mills, foundries and welding shops are subject of folder.

78. SAFETY SHIELD—Singer Glove Mfg. Co. Portable protective shield for welding or other operations is covered in catalog sheets which include prices.

79. STUD WELDER—Shielded Stud Welding Co. Flyer details and illustrates pistol-shaped portable stud welder.

80. GOGGLE-RESPIRATOR — American Optical Co. Folder S-8016 describes Drednaut series respirator-goggle combination.

81. CYLINDER TRUCKS—Welding Alloys Mfg. Co. Catalog sheet details models 2 and 3 cylinder trucks, welding hoses and couplings.

82. METALS LIST—Whitehead Metal Products Co., Inc. Nickel, Monel, Inconel and Incoloy in sheet, rod, pipe, tube, wire, and other forms are detailed in stock list booklet.

83. NON-SYNCHRONOUS CONTROL — General Electric Co. New customline non-synchronous control for resistance welding is covered in bulletin GEA-6593.

84. PIPE BEVELER—C. A. Mathey Machine Works Inc. Uses, operation and specifications for company line of pipe beveling and cutting machines is covered in brochure.

85. WELDING WIRE—Kaiser Aluminum and Chemical Sales Inc. Company's inert gas welding wire is subject of booklet describing Tig process it is used with and its availability.

86. BRAZING CEMENT—Wall Colmonoy Corp. Engineering data sheet No. 7 discusses Nicrobraz cement for applying brazing alloys for high-temp service.

87. HARDFACING—Lincoln Electric Co. Bulletin 7000.2 is a procedure guide for company manual arc welding electrodes for hardfacing and welding stainless steels, nonferrous metals and cast iron.

88. ELECTRONIC TRACER — National Cylinder Gas. Booklet N-142 details electronic line tracer which is used to guide company flame cutter.

89. REGULATORS—Air Reduction Sales Co. Bulletin 806 covers company's complete line of cylinder, manifold and station pressure regulators. Flow and pressure specifications as well as inlet and outlet connection dimensions are given.

90. ELECTRICAL CONNECTIONS—Erico Products Inc. Firm's latest catalog details aluminum as an electrical conductor and covers line of aluminum electrical connections.

91. ULTRASONICS—Acoustica Associates. Flyer pictures how ultrasonics cleans and solders metals.

92. X-RAY EQUIPMENT—Mitchell Radiation Products Corp. Manufacturer's Isovolt 300 and 400 series inspection units are detailed and illustrated in use in new pamphlet.

93. ALUMINUM SOLDER — Chemalloy Electronics Corp. Step-by-step procedure for using company's aluminum solder is explained and pictured on special card.

94. BLASTING NOZZLES — Clementina Ltd. Line of Norbide-lined venturi style blast cleaning nozzles for use with any style blasting equipment are covered in catalog.

95. RECTIFIERS — Syntron Co. Selenium rectifiers, circuits and stack coding are presented in eight-page bulletin. Cartridge and vacuum process rectifiers are detailed.

96. TUBE SHAPING—McBeth Machinery Co. "Shape cutting of tubes," is a reprint company is offering which explains and illustrates methods of intersecting joining and elbowing tubes.

97. STEEL COSTS—American Steel Warehouse Association. "What's your real cost of possession of steel?" is a publication designed to assist steel buyers in determining their true cost of steel ready for use.

98. HEAT EXCHANGERS—Reynolds Metals Co. "Reynolds aluminum for heat exchangers," summarizes in 16 pages of charts and pictures, technical information needed by the heating engineer, fabricator and industrial buyer.

99. EXHAUST SYSTEM—Car-Mon Products Inc. Dual Tab-L-Exhauster for removing fumes and exhaust in welding operations is described in special booklet.

100. PRESS-BRAKES—Taylor-Winfield Corp. Bulletin 13-693 describes line of press brakes. Includes specifications, dimensions and force required to bend mild steel.

101. HYDRAULIC VALVES—Rivett Inc. A new manual illustrating and explaining the operation and application of pressure controlled hydraulic valves is available.

102. SWING GRINDER—Ryman Engineering Co. Heavy duty swing grinder for various applications is covered in flyer.

103. WELDING POSITIONER — Weldma Co. Brochure gives specifications for Model SA 40-P-1 which handles assemblies weighing up to 4,000 lb.

104. GAS-AIR MIXER—Waukee Engineering Co. Bulletin 420 shows all features of Type "R" Mixer, a precision compressor-carburetor device with versatile applications for both mixing and compressing of gas-air mixtures.

105. SEAMLESS WELD FITTINGS — Babcock & Wilcox Co. Booklet FB-78 serves as guide to material selection of carbon, alloy and stainless steel welding fittings and flanges. General catalog data is included.

106. LIQUID-GAS CONTAINER—Ronan & Kunzl, Inc. Data sheet pictures Model LOX 150 a vacuum insulated liquefied gas storage and transfer container with 150-gal capacity.

107. HOSE ACCESSORIES—Hose Accessories Co. Condensed catalog No. 34 contains basic data on LE-HI hose couplings and fittings for every type of industrial rubber hose.

108. REPAIR EQUIPMENT—National Cylinder Gas. Bulletin NM-112 is intended for hospitals and other users of medical gases and inhalation equipment.

109. COATED FABRICS—Reeves Brothers Inc. Catalog shows Reevecote fabrics, including both natural and synthetic fabrics, that are coated with natural and synthetic rubbers. Among the many applications of such fabrics are welding curtains and diaphragms for gas meters, vacuum pumps, etc.

110. PROTECTION PRODUCTS — Sellstrom Mfg. Co. Bulletin 35-F contains many Sellstrom Safeguards, including welding goggles, helmets, face shields, respirators, etc.

111. X-RAYS OF PIPELINES—Gevaert Co. of America, Inc. Booklet deals with radiography in construction of pipelines, inspection of welded joints, and a tabulation of welding defects.

112. AIR COMPRESSOR — Mine Safety Appliances Co. Bulletin 1009-2 shows applications of diaphragm-type air compressor that includes one air line respirator, or one air line hood.

113. GRINDING WHEELS DATA—American Emery Wheel Works. Eight page brochure, "How to order American grinding wheels," contains the standard markings for grinding wheels and suggestions on proper selection. Five pages are tabulated recommendations covering all types of materials and jobs, including welds.

114. CUTTING TORCHES—Air Reduction Sales Co. Catalog ADC-880 contains all of Airco's machine cutting torches, including tips and accessories.

115. WELDORS' TOOLS—Atlas Welding Accessories Inc. Catalog form WCT 250 shows Super-Tomahawks and Hammers, and assortment of Dual-Tools. Also shown are full-wood handle hammers, and the new Easy-Grip Tomahawks. Complete specifications are given.

116. SURFACING COMPOUND—Krembs & Co. Flyer on Fluxine No. 101 states that this hardfacing compound is less expensive to use on steel shanks, cutting tools, etc., than other types of hardfacing rods.

117. INDEXING WHEEL—Weldma Co. Flyer pictures use of RWT-1003 wheel holder with electrode tips, which facilitates resistance-welding electrode servicing or replacement. Device has eight internally water-cooled electrode tips.

118. BLOWER-SUCTION CLEANERS—Clements Mfg. Co. Bulletin covers complete line of standard blower-suction cleaners, includes a special 2-speed model.

119. STAINLESS TUBING—Babcock & Wilcox, Tubular Products Div. Data Card 192 gives properties, composition and sizes for B & W Croloy 25-12 (TP 309).

120. BELT KEY-REEL—Lummis Mfg. Co. Brochure describes uses for "Key-Bak", key reel to be worn on belt of weldors. Newest model can be used to hold small tools as well as flint-lighter and keys.

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Acro Welder Mfg. Co. 106
Air Reduction Sales Co. 17
Air Reduction Sales Co. Tuffaloy Dept. 103
Allen Co., Inc., L. B. 110
Allis Chalmers Mfg. Co. 108
Alloy Rods Co. 21
All-State Welding Alloys Co., Inc. 104
American Brass Co. ..... Back Cover
American Chain & Cable Co.
Page Steel & Wire Div. 28
American Optical Co. 87
American Platinum & Silver Div.
Engelhard Industries, Inc. 4
Ampco Metal, Inc. 16
Ansco X-Ray
General Aniline & Film Corp. 85
Atlantic Abrasive Corp. 101
Atlas Welding Accessories, Inc. 18

Belden Mfg. Co. 63
S. Blickman, Inc. 106

Cam-Lok Div. 98
Contour Sales Corp. 56
M. J. Crose Mfg. Co. Inc. ..... Inside Front Cover

Douglas Aircraft Co. 108
Drawalloy Corp. 97

Electric Arc, Inc. 99
Engelhard Industries, Inc.
American Platinum & Silver Div. 4
Engwald Corp. 102
Eutectic Welding Alloys Corp. 89

Flood Safety Products Co. 107

General Aniline & Film Corp.
Ansco X-Ray 85
Goldsmith Bros. Smelting & Refining Co. 20

Handy & Harman 26
Harnischfeger Corp. 61
Harrisburg Steel Co. 5
Harris Calorific Co. 13
Haynes Stellite Co. 55
Hobart Bros. Co. 1, 2

IBM Corporation 108
Independent Engineering Co., Inc. 100

Jackson Products 6
Johns-Manville Corp. 88

Leach & Garner Co. 86
Lenco, Inc. 94
Lincoln Electric Co. 22, 23
Linde Co. 11, 47

Mallory & Co., Inc. P. R. 10
Manhattan Rubber Div.
Raybestos-Manhattan Inc. 19
Merrill Bros. 100
Messer Cutting Machines, Inc. 59
Miller Electric Mfg. Co. Inc. ..... Front Cover, 24

National Carbide Co. 105
National Welding Equipment Co. 9

Page Steel & Wire Div.
American Chain & Cable Co. 28
Phoenix Products Co. 92
Pressed Steel Tank Co. 96

J. M. Ragle Industries 107
Raybestos-Manhattan Inc.
Manhattan Rubber Div. 19
Rankin Mfg. Co. 90
Reid-Avery Co. 95
Ronan & Kunzl, Inc. 106
Ruemelin Mfg. Co. 104

Singer Glove Mfg. Co. 106
A. O. Smith Corp. 65-80
Smith Welding Equipment Corp. 27
Square D Co. 64
Stulz-Sickles Co. 102
Sylvania Electric
Products Inc. ..... Inside Back Cover

Tempil Corp. 91
Tennessee Fabricating Co. 84
Thermacote Co. 105
Tillman & Co., John 104
Tuffaloy Dept., Air Reduction Sales Co. 103

Vickers Inc. 12
Victor Equipment Co. 30

Welding Engineer 14, 107, 108
Welsh Mfg. Co. 103
Westinghouse Electric Corp. 49, 51, 53
Worthington Corp. 82, 83

Literature offered in ads

150. Acro Welder Mfg. Co.—Write for further information on welding machinery, engineered and manufactured to order.

151. Air Reduction Sales Co.—Further information on "Arcstart" electrodes available.

152. Alloy Rods Co.—A report to piping contractors on "Atom-Arc" iron powder, low hydrogen electrodes is available.

153. All-State Welding Alloys Co., Inc.—Booklet and chart on all types of aluminum welding wire is available.

154. American Brass Co.—Further information on "Anaconda" welding rod and wire is available.

155. American Optical Co.—Write for further information on AO "Kool-Vent" face shield and other safety products.

156. American Platinum & Silver Div.—"A Complete Guide To Selective Fluxing For Low Temperature Silver Brazing" is available.

157. American Platinum & Silver Div.—Also available is, "A Complete Guide To Successful Silver Brazing."

158. Ampco Metal, Inc.—Bulletin W-17 gives detailed facts on the complete Ampco welding line.

159. Ansco, Div. of General Aniline & Film Corp.—Write for further information on Ansco's x-ray films.

160. Atlantic Abrasive Corp.—Grinding wheel catalog available to help you with your metal removal or smoothing problems.

161. Atlas Welding Accessories Inc.—Write for form WCT-250, describing the "Dual Tools" and other weld cleaning tools.

162. S. Blickman, Inc.—Write for technical bulletins on various types of welding enclosures.

163. Cam-Lok Div.—Bulletin No. 301 on the complete line of Receptacles and Plugs is available.

164. Contour Sales Corp.—Data available on "Curv-O-Mark" pipe-layout tools, for marking pipes and structural angle cuts of any type.

165. M. J. Crose Mfg. Co., Inc.—Further information on Crose welding accessories is available, also information on distributorships to established welding supply companies.

166. Drawalloy Corp.—For complete information on every grade of Drawalloy wire write for bulletin 355DC.

167. Electric Arc, Inc.—Brochure available, "Smith-Dolan System of Low-Frequency Induction Heating."

168. Engwald Corp.—Catalog WE-9 on welding fumes exhausters available.

169. Eutectic Welding Alloys Corp.—Data book on "Low Temperature Welding Alloys" available.

170. Flood Safety Products Co.—Information available on fiber glass helmets and other welding and safety equipment.

171. Goldsmith Brothers Smelting & Refining Co.—Write for further information on "GB 88 Flux" for silver brazing.

172. Handy & Harman—Bulletin 20 explains silver brazing and its benefits.

173. Harnischfeger Corp.—Further information available on "P&H" welding equipment and electrodes.

174. Harrisburg Steel Co.—Write for more information on gas cylinders manufactured by Harrisburg.

175. Harris Calorific Co.—Further details available on the Harris unit for machine cutting torches.

176. Haynes Stellite Co.—Booklet available, "Haynes Alloys Hard-Facing" manual.

177. Hobart Brothers Co.—Complete details available on the new automatic wire feeder "Manumatic."

178. Hobart Brothers Co.—Further information on the new Hobart No. 212 electrode and sample available.

179. Independent Engineering Co.—Information available on acetylene cylinders manufactured by Independent.

180. Jackson Products—Further information available on duty-cycle rated holders.

181. Johns-Manville Corp.—Data available on J-M Aluminized Asbestos Cloth.

182. Leach & Garner Co.—Technical Data Sheet No. 501 available on silver brazing alloys.

183. Lenco, Inc.—Further information on "Threaded Power Connection" is available.

184. Lincoln Electric Co.—Write for information on Lincoln's arc welding equipment.

185. Linde Co.—Further information on the Purox "E" cutting blowpipe available, also name of your nearest distributor.

186. Linde Co.—Write for additional information on the new "Mighty Midget" welder.

187. P. R. Mallory & Co.—Chart available, "Do's and Don'ts for Resistance Welding."

188. Manhattan Rubber Div.—Write for details on Moldiscs Abrasive wheels for weld grinding.

189. Merrill Brothers—Information available on material handling devices.

190. Messer Cutting Machines, Inc.—Further information on oxygen cutting and automated cutting equipment is available.

191. Miller Electric Mfg. Co., Inc.—Complete information on the new Miller "Twin" welders and a list of features will be sent on request.

192. Miller Electric Mfg. Co., Inc.—Complete specifications on the "Gold Star" welders available.

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Also information about

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★ For copies of any manufacturers bulletins described on these pages circle the number of the items on card at right. Fill in your name, title, company and address. This has to be done only once on either post card. You need no postage.

★ For additional information on New Products described in this issue, circle the numbers of the items that interest you. The New Products section begins on page 94.

WARNING!

Illegible or incomplete addresses may keep you from receiving the information you desire. And remember, cards postmarked after the deadline date cannot be processed.

★Post card not valid after three (3) months. After that, write *directly to the manufacturer*, describing fully the information and/or literature wanted.

Name_____ Title_____

Company_____

Address_____

City_____ State_____ 9/59

NOT GOOD AFTER DECEMBER 1, 1959

WELDING ENGINEER, P. O. Box 28, Morton Grove, Ill.

Please send me without obligation further information about the following:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
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BUSINESS REPLY CARD

First Class Permit No. 32, Morton Grove, Ill.

Welding Info-Aids,
Welding Engineer
P.O. Box 28
Morton Grove, Ill.

Literature offered in ads

(Continued from page 112)

193. **National Carbide Co.**—Write for additional information on calcium carbide and name and address of your nearest distributor.

194. **National Welding Equipment Co.**—Illustrated folder #17 gives you all the information regarding the new "Five Star Pak."

195. **Page Steel & Wire Div.**—Folder available on submerged arc and inert gas automatic welding wire.

196. **Phoenix Products Co.**—Write for new folder, "DryRod as Standard Welding Equipment."

197. **Pressed Steel Tank Co.**—Bulletin available "Seamless High Pressure Gas Cylinders."

198. **J. M. Ragle Industries**—Write for further information on the "Cammando" drill kit and other "Commando" products.

199. **Rankin Mfg. Co.**—Additional information on "Ranite" hardsurfacing rods available.

200. **Reid-Avery Co., Inc.**—Write for the complete "Raco" catalog.

201. **Ronan & Kunzl, Inc.**—Information available on storage and transport containers.

202. **Ruemelin Mfg. Co.**—Detailed information on the Ruemelin portable fume collector.

203. **Singer Glove Mfg. Co.**—Catalog on complete line of work gloves, welding gloves and safety clothing is available.

204. **A. O. Smith Corp.**—Write for further information on A. O. Smith's welding machines.

205. **Smith Welding Equipment Corp.**—Further information available on "Push Button Gas Control."

206. **Square D Co.**—Bulletin SM-277 explains the new "plug in" welder control.

207. **Stulz-Sickles Co.**—Complete details on "Manganal" wedge bars and name of your nearest distributor available.

208. **Sylvania Electric Products Inc.**—Write for additional information on Sylvania tungsten electrodes.

209. **Tempil Corp.**—Sample of Tempil pellets and information on "Tempilstik" available.

210. **Tennessee Fabricating Co.**—New catalog on over 400 casting designs, tubing, welding, rods and machine tools and supplies is available.

211. **Thermacote Co.**—Write for further information on "Thermo Sta-Kleen" cover lens and free sample.

212. **John Tillman & Co.**—Write for catalog on weldor's gloves and garments.

213. **Tuffaloy Dept.**, Air Reduction Sales Co.—Catalog and prices on Tuffaloy spot welding tips, tip holders and adapters.

214. **Vickers Inc.**—Electric Products Div.—Descriptive bulletins 7136-1 and 7146-1 available on the "Controlarc" for standard arc welding, constant potential welding and tungsten inert gas welding.

215. **Victor Equipment Co.**—Further information available on Victor torches and dealerships in few areas.

216. **Welsh Mfg. Co.**—Write for further information on Welsh safety goggles.

217. **Westinghouse Electric Corp.**—Further information available on the new d-c silicon welder.

218. **Worthington Corp.**—Additional information on Worthington positioners available.

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TIG welding is "right" for so many jobs...

Outdoor furniture made of steel tubing, is TIG-welded for smooth, slag-free welds and greater strength

Magnesium ramp for trailer trucks features rugged TIG welding of plates and channels

...and Sylvania Tungsten Electrodes do the job right...everytime!

FROM lightweight outdoor furniture to giant magnesium truck-ramps . . . Tungsten Inert Gas Welding is adaptable to almost any job. But the quality of the weld is only as good as the tools you use . . .

That's why TIG welders prefer Sylvania Tungsten Electrodes. You can take your pick of all 4 electrode types: Puretung®, Zirtung®, 2% Thoriated, 1% Thoriated. They're available with cleaned or ground finish. And they're color-coded to prevent waste and costly errors.

Sylvania Tungsten Electrodes are available through all leading distributors. Call yours today.

SYLVANIA

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Sylvania Electric Products Inc.
Chemical & Metallurgical Div.
Towanda, Penna., U.S.A.

BRAZE WELDING adds strength, helps prevent squeaks, leaks, and rattles in Rambler's all-welded, single-unit construction of body and frame.

Extension side roof and roof panel on a Rambler Cross Country station wagon being joined by oxyacetylene braze welding with Anaconda-997 (Low Fuming) Bronze Rod. Braze weld between rear quarter pillar and side roof rail (to left) is one of several made primarily to prevent water leakage. American Motors welding engineers have found braze welding with Anaconda-997 (Low Fuming) Bronze Rod to be an efficient and economical production tool. The alloy bonds to steel easily. The relatively low application temperature minimizes distortion and makes it easy to control weld metal. Welding operations on a moving assembly line are fast, and finishing time is reduced. The rod's low fuming characteristics make normal ventilation facilities adequate.

There are up to 30 areas, depending on the model, where braze welding is used to augment electric welding to give American Motors Ramblers an all-welded, single-unit construction of body and frame with high strength, safety, and quiet operation. American Motors claims for this construction elimination of squeaks and rattles, also better utilization of space and greater durability.

OXYACETYLENE braze welding is being used increasingly for economical assembly of many steel articles which do not lend themselves to joining by arc welding or resistance spot welding. Applications range from auto bodies and appliance cabinets to frames for bicycles. In most cases, Anaconda distributors can help you select the rod for your job. But if you have a special problem, Anaconda welding engineers are at your service. Write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

5979

ANACONDA®

WELDING ROD AND WIRE

Made by The American Brass Company